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An Assessment of Corn Growers' Awareness towards Silage Production in Bachok, Kelantan

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ABSTRACT

Corn growers often face challenges in managing crop residues such as cornstalks, stems, and leaves after harvest. When left unmanaged, these residues can serve as a habitat for pests and plant pathogens, creating challenges for subsequent crop management. Many farmers resort to open burning, contributing to environmental pollution and undermining sustainable agricultural practices. An eco-friendly alternative is converting corn residues into silage, a preserved, high-quality livestock feed that enhances animal nutrition while reducing agricultural waste. This study assessed the awareness of silage production among thirty corn growers in Bachok, Kelantan, and the relationship between demographic profiles and awareness levels was examined. Data were collected through a structured survey and analysed using correlation and regression techniques. The findings revealed that corn growers generally exhibited a high level of awareness regarding silage production, particularly its role in waste reduction and livestock feeding improvement. Farm size showed a significant positive relationship with awareness of silage preservation benefits ($r = 0.394$, $p < 0.05$), while farmers rearing non-ruminant livestock demonstrated lower awareness of silage as a cost-saving feed option ($r = -0.509$, $p < 0.01$). Regression analysis indicated that yield per season significantly predicted awareness levels, whereas age, education, and income had a limited influence. These findings highlight the importance of targeted extension services and practical training programmes to enhance sustainable crop residue management through silage production in Malaysian agriculture.

1. INTRODUCTION

Silage production is widely recognised as a critical practice in sustainable livestock feeding and crop residue management. By preserving forage and crop residues under anaerobic conditions, silage provides a practical solution to forage shortages while reducing agricultural waste (Zhang et al., 2020; Falan et al., 2021). Corn is an important agricultural crop that contributes to food security and livestock feed production worldwide, particularly in corn-based farming systems. Residues such as stalks and leaves are utilised as

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silage supports in integrated crop–livestock systems, helping minimise environmentally harmful practices, including open burning (Battaglia et al., 2020). In Malaysia, grain corn production has received increasing attention due to the country's heavy dependence on imported corn for the livestock feed industry. To reduce import dependency, the government has introduced various initiatives to expand domestic grain corn cultivation, particularly in states with suitable agroecological conditions (Department of Agriculture Malaysia, 2020). Bachok, Kelantan, is among the areas identified for grain corn development, where commercial cultivation has been promoted since 2019 as part of efforts to strengthen local feed production (Razak, 2022).

Despite the availability of corn residues after harvest, silage production among smallholder corn growers remains limited. In many cases, residues are left unused or disposed of without value addition, indicating that adoption challenges persist (Butzen et al., 2024). Previous studies suggest that the adoption of agricultural innovations is influenced not only by technical feasibility but also by farmers' demographic characteristics, such as farm size, production capacity, and livestock type (Valdez et al., 2023). However, empirical evidence examining the relationship between demographic profiles and awareness of silage production among corn growers in Malaysia remains limited, particularly at the local level.

Accordingly, this study aims to assess the awareness levels of silage production among corn growers in Bachok, Kelantan, and to examine the relationship between growers' demographic profiles and their awareness of silage production. The findings are expected to contribute to sustainable residue management and the promotion of integrated crop–livestock systems in Malaysia. To address the second research objective, the following alternative hypothesis was formulated: H1: There is a significant relationship between the demographic profiles of corn growers and their awareness levels of silage production in Bachok, Kelantan.

2. LITERATURE REVIEW

2.1 Corn Production in Malaysia

Corn was introduced in Malaysia in the early 1970s, and since then, it has developed into an essential crop for both food and feed purposes (Department of Agriculture Malaysia, 2008). Among the various corn types cultivated globally, Malaysian production primarily focuses on sweet corn (*Zea mays saccharata*) and grain corn (*Zea mays indurata* and *Zea mays indentata*) (Tan & Wong, 2007). Grain corn plays a crucial role in the livestock sector, particularly as the main energy component in poultry feed formulations, accounting for approximately 40–60%, while soybean contributes as the primary protein source (Department of Agriculture Malaysia, 2020). The cultivation cycle also differs by variety, with sweet corn requiring a shorter growing period of about 70 days, whereas grain corn typically matures within 100–105 days (Mohammad Nor et al., 2020).

Despite its importance, domestic grain corn production remains limited, resulting in heavy reliance on imports to meet the growing demand for animal feed. Grain corn imports have increased steadily over the years, driven by expansion in the livestock industry, highlighting structural dependency on external sources. In response, the Ministry of Agriculture and Food Industry has prioritised the local corn industry as part of national food security strategies. At the state level, Kelantan has actively promoted corn cultivation as a long-term alternative feed source, particularly in areas such as Bachok, where several corn varieties have been cultivated since 2019 with promising yields (Razak, 2022). This is relevant to the present study as it reflects similar corn production initiatives within the study context.

2.2 Corn Residues and Silage Potential

Crop residues refer to the biomass remaining after the harvest of the main agricultural product, including stalks, leaves, husks, and stubble (De et al., 2021). These residues are commonly utilised for various purposes such as fuel, livestock bedding, and soil nutrient recycling, either directly or through composting. In corn production systems, residues represent a substantial proportion of total biomass, with approximately 45–50% of the aboveground plant material remaining after grain harvest (University of Nebraska Institute

of Agriculture and Natural Resources, 2019). Studies have demonstrated that corn residues, particularly corn stover, can be effectively repurposed within circular agricultural systems. For instance, Maeda (2020) found that corn stover served as a suitable bulking agent in dairy manure composting, contributing to environmentally sustainable and resource-efficient dairy farming practices.

Beyond soil and waste management applications, corn residues hold significant potential as silage for livestock feeding. The conversion of green corn biomass into silage has been shown to enhance animal productivity, particularly in dairy systems. Evidence from Cagayan Valley indicates that green corn silage substantially increased milk production among dairy cattle and buffalo, while also creating income-generating opportunities through silage marketing (Cañete & Alvarez, 2021). Moreover, silage production has been associated with improved farm profitability. Wang et al. (2022) reported that corn silage production significantly reduced production costs and increased farmers' income compared to grain corn cultivation, with estimated income gains of approximately CNY 101 per mu (≈ RM 66 per mu, based on an exchange rate of 1 CNY ≈ RM 0.65). These findings highlight the economic and functional value of corn residues when efficiently utilised as silage, reinforcing their potential role in sustainable and integrated crop–livestock systems, which may be relevant to smallholder farmers in Malaysia under similar production conditions.

2.3 Farmers' Awareness and Adoption of Silage Practices

Farmers' adoption of silage-making practices is closely associated with their level of awareness, shaped by socio-economic and institutional factors. Previous studies indicate that education level, farming experience, financial capacity, and access to extension services significantly influence farmers' understanding and adoption of forage conservation technologies. Balehegn et al. (2021) conducted a study in Sub-Saharan Africa that identified limited knowledge and technical skills, inadequate machinery, and insufficient resources for silo construction as major constraints to silage adoption. These findings suggest that awareness alone may be insufficient without adequate institutional and financial support to translate knowledge into practice.

Empirical evidence demonstrates that demographic characteristics play a critical role in shaping farmers' readiness to adopt silage practices. A study conducted in Kiruhura District, a rural area in the Western Region of Uganda where livestock and smallholder farming are the main agricultural activities, found that factors such as education level, household income, access to labour and credit, participation in agricultural exhibitions, and exposure to on-farm demonstrations significantly influenced the adoption of fodder production technologies (Robert et al., 2020). The relationship between education and technology adoption has long been supported, with higher levels of schooling increasing the likelihood of adopting agricultural innovations (Daberkow & McBride, 2003). Additionally, Martínez-García et al. (2020) reported that greater farming experience and access to financial resources, machinery, and technical knowledge strengthened farmers' intentions to continue using corn silage. These studies highlight the importance of demographic and resource-related factors in enhancing farmers' awareness and adoption of silage practices.

3. METHOD

A quantitative, cross-sectional survey design using a purposive sampling technique was utilised, comprising thirty registered corn growers in Bachok, Kelantan, who had received Incentive Input Assistance from the Department of Agriculture Malaysia. Data were collected using a structured questionnaire administered to all identified growers. Although the sample size is relatively small, it is considered acceptable for exploratory and localised studies involving a defined population (Hair et al., 2014). In addition, a minimum sample size of 30 is generally regarded as sufficient for detecting moderate relationships in correlation analysis (Cohen, 1992).

3.1 Data Instrumentations

The questionnaire consisted of two sections. Section A captured respondents' demographic profiles, including age, education level, farm size, livestock type, and production characteristics. Section B assessed growers' awareness of silage production using a set of structured statements measured on a Likert scale. Instrument reliability was evaluated using Cronbach's Alpha to ensure internal consistency.

3.2 Data Analysis

Data analysis was conducted using IBM SPSS Statistics Version 29. Descriptive statistics, including frequencies, percentages, means, and standard deviations, were used to summarise respondents' demographic characteristics and awareness levels. Pearson correlation analysis was applied to examine the strength and direction of relationships between demographic variables and awareness of silage production, with statistical significance set at $p < 0.05$. The interpretation of correlation coefficients followed the rule of thumb suggested by Hair et al. (2014). Multiple linear regression analysis was subsequently performed to identify key demographic factors influencing growers' awareness of silage production.

3.3 Conceptual Framework

The research framework outlines the relationships between the independent and dependent variables examined in this study. The independent variables comprise the demographic profiles of corn growers, including selected socio-economic and farm-related characteristics. The dependent variable represents growers' awareness levels of silage production as a viable agricultural practice. The conceptual framework of the relationship between these variables is illustrated in Fig. 1.

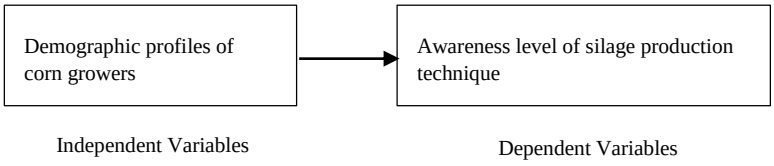

Fig. 1: Conceptual Framework

4. FINDINGS & DISCUSSION

4.1 Reliability Analysis

The reliability of the Likert-scale questionnaire was evaluated using Cronbach's Alpha to assess internal consistency. As presented in Table 1, the awareness construct recorded a Cronbach's Alpha coefficient of 0.830, indicating good internal reliability. This result confirms that the measurement items consistently represent the intended construct and are suitable for subsequent statistical analysis.

Table 1. Reliability Analysis

Variable	Cronbach's Alpha	No. of items
Corn growers' awareness of silage production	0.830	5

4.2 Demographic profiles of corn growers

The demographic profile of corn growers in Bachok, as presented in Table 2, indicates notable structural characteristics within the farming community. Most respondents were male (80%) and aged 45 years and above (73.4%), reflecting an ageing and gender-imbalanced grower population. Similar demographic attributes, including age, gender, education level, and farming experience, have been shown to influence farmers' adoption of agricultural technologies (Akudugu et al., 2023). Most respondents attained

secondary-level education (80%), while only a small proportion possessed tertiary education (13.3%), suggesting limited exposure to advanced agricultural knowledge. The respondents were ethnically homogeneous (100% Malay), which may facilitate community-based extension delivery. In terms of farm characteristics, most growers reared cattle, had farming experience of less than five years (53.3%), operated small landholdings of 2–5 acres (60%), recorded yields below 1,000 cobs per acre (90%), and earned monthly incomes below RM2,500 (60%). These findings reflect constraints in productivity and scale, which may affect the capacity of growers to adopt improved practices, consistent with evidence that farm size and resource availability significantly influence technology uptake and farm performance (Wu, 2022).

Table 2. Demographic profiles of corn growers (N=30)

Items	Category	Frequency	Percentage (%)
Gender	Male	24	80
	Female	6	20
Age	26 – 44	8	26.7
	45 – 59	11	36.7
	>60	11	36.7
Race/ Ethnicity	Malay	30	100
Highest educational background	No formal education	1	3.3
	Primary school	1	3.3
	Secondary school	24	80
	Tertiary education	4	13.3
Types of livestock raised	None	12	40
	Cattle	14	46.7
	Goat	4	13.3
Years of experience in farming	< 5 years	16	53.3
	6 – 10 years	4	13.3
	11 – 15 years	3	10
	>16years	7	23.3
Agricultural farm size (acres)	>1 acre	11	36.7
	2 – 5 acres	18	60
	6 – 9 acres	1	3.3
Yield (season/acre)	< 1000 cobs	27	90
	2 – 5 acres	2	6.7
	6 – 9 acres	1	3.3
Average agricultural income per month	<RM2,500	18	60
	RM2,501 – RM5,000	1	3.3
	RM5,001 – RM 10,000	8	26.7
	>RM10,000	3	10

4.3 Descriptive Statistics on Corn Growers' Awareness of Silage Production

A mean score of 4.066 was used as the benchmark to classify awareness levels into high (≥ 4.066), moderate (3.67 to < 4.066), and low (< 3.67). The results indicate that corn growers demonstrated a generally high level of awareness regarding key aspects of silage production (Table 3). Most respondents recognised that cornstalks can be utilised for silage (86.7%, M = 4.20), contribute to the reduction of agricultural waste (83.3%, M = 4.13), and serve as quality livestock feed (76.7%, M = 4.13). Moderate awareness levels were

observed for silage preservation benefits (73.4%, M = 3.97) and its potential to reduce feed costs (70.0%, M = 3.90). These findings suggest a positive perception of silage as a sustainable agricultural practice and indicate readiness for wider adoption (Guo et al., 2021; Wang et al., 2024). However, variation in responses highlights gaps in understanding, particularly regarding technical preservation processes and economic returns. Previous studies have shown that field-stored cornstalks are susceptible to nutrient loss, whereas proper ensiling provides a stable anaerobic environment that preserves feed quality (Wahlberg, 2004; Borreani et al., 2018). This result may explain why, despite high general awareness, some farmers remain cautious about fully adopting silage practices, underscoring the need for targeted technical training and practical demonstrations that emphasise both preservation quality and cost-saving benefits (John & Caroline, 2023).

Table 3. Reliability analysis

Variable	Cronbach's Alpha	No. of items
Corn growers' awareness of silage production	0.830	5

4.4 Pearson Correlation Analysis

Table 4 presents the correlation results examining the relationship between selected demographic variables and corn growers' awareness of silage production in Bachok, Kelantan. The analysis revealed a statistically significant weak positive correlation between farm size and awareness that silage preserves cornstalks more effectively than leaving them in the field, suggesting that growers operating larger farms tend to have greater awareness of silage preservation benefits, possibly due to increased exposure to modern farming practices. This finding is consistent with Obrycki and Karlen (2018), who reported that while technology adoption may not differ substantially by farm size, larger farms often demonstrate a stronger functional understanding of the economic value of crop residue utilisation. Conversely, a significant moderate negative correlation was observed between livestock type and awareness of silage as a cost-saving feed option, indicating that farmers rearing non-ruminant livestock exhibit lower awareness compared to those managing ruminants such as cattle. This result aligns with Valdez et al. (2023), who found higher silage adoption rates among ruminant farmers due to its recognised nutritional and economic advantages. Overall, the findings validate the study's hypothesis (H1), confirming a significant relationship between the demographic profiles of corn growers and their awareness levels toward silage production in the region.

Table 4. Pearson correlation between demographic profiles and awareness of silage production among corn growers (N=30)

Variables	Correlation Coefficient (r)	p–value	Strength (Hair et al., 2014)
Farm size (acres) and awareness (silage preserves cornstalks)	0.394*	0.031	Weak positive correlation
Types of livestock and awareness (cost-saving feed)	-0.509**	0.004	Moderate negative correlation

** Correlation is significant at the 0.01 level (2-tailed)

* Correlation is significant at the 0.05 level (2-tailed)

4.5 Multiple Linear Regression Analysis

The multiple regression analysis examined the influence of selected demographic factors on corn growers' awareness of silage production in Bachok, Kelantan (Table 5). The model explained 35.9% of the variance in awareness ($R^2 = 0.359$); however, the adjusted R^2 was considerably lower (0.115), indicating limited explanatory power beyond the study sample. The ANOVA results (Table 6) showed that the overall model was not statistically significant, suggesting that the demographic variables collectively did not provide a strong prediction of awareness levels.

Nevertheless, the coefficient analysis (Table 7) identified yield per season as the only significant predictor of awareness, indicating that higher-yielding farmers tended to exhibit greater awareness of silage as a cornstalk preservation practice. This finding may be explained by the greater availability of crop residues among higher-yielding farmers, which increases their motivation to explore alternative residue management strategies such as silage production. Farmers with higher production volumes may also have greater exposure to commercial farming practices and information related to livestock feed utilisation.

Similarly, Wang et al. (2022) reported that corn silage production can provide economic advantages through higher biomass yield compared with grain production, encouraging farmers to consider silage as a value-added option. Moreover, many farmers in Thailand have adopted narrow plant spacing to achieve greater plant densities for corn silage, which has successfully increased dry matter yield per hectare (Chayanont et al., 2021). However, the non-significant influence of age, education level, farm size, livestock type, and farming experience may be attributed to the relatively homogeneous characteristics of the respondents and the limited sample size. Previous studies have highlighted that access to extension services, training exposure, and practical experience may have stronger influences on technology awareness and adoption than demographic characteristics alone (Balehegn et al., 2021; Valdez et al., 2023).

Table 5. Model summary for demographic predictors of silage awareness

Model	R	R Square	Adjusted R-Square	Std. error of the Estimate
1	.600[a]	.359	.115	1.003

Predictors: (Constant), Agricultural income (RM/season), Yield (season/acre), Age, Gender, Types of livestock, Farm size (acre), Educational level, Years of experience

Table 6. ANOVA table for demographic predictors of silage awareness

Model		Sum of Squares	*df*	Mean Square	*F*	*Sig.*
1	Regression	11.850	8	1.481	1.473	.226[b]
	Residual	21.117	21	1.006		
	Total	32.967	29			

Dependent Variable: Silage preserves cornstalks better than leaving them in the field
Predictors: (Constant), Agricultural income (RM/season), Yield (season/acre), Age, Gender, Types of livestock, Farm size (acre), Educational level, Years of experience

Table 7. Coefficient for demographic predictors of silage awareness

Model		Unstandardised Coefficients		Standardised Coefficients		
		B	Std.Error	Beta	*t*	*Sig.*
1	(Constant)	1.897	2.196		.864	.397
	Gender	.242	.483	.092	.501	.622
	Age	.008	.295	.006	.027	.979
	Educational level	.270	.436	.141	.620	.542
	Types of livestock	-.019	.314	-.012	-.0.61	.952
	Years of experience	-.154	.257	-.184	-.598	.556
	Yield (season/acre)	**1.134**	**.506**	**.581**	**2.239**	**.036**
	Farm size (acres)	.049	.526	.020	.092	.927
	Agricultural income (RM/season)	-.356	.217	-.379	-1.644	.115

Dependent Variable: Silage keeps cornstalks better than the field

5. CONCLUSION

The findings indicate that corn growers in Bachok, Kelantan, generally exhibit high awareness of silage production, particularly in relation to its role in utilising cornstalks as livestock feed, reducing agricultural

waste, and supporting animal nutrition. However, awareness was only moderate regarding silage's feed preservation quality and cost-saving potential, indicating uneven understanding and limited practical exposure. Correlation analysis revealed significant associations between selected demographic factors and awareness, where farm size was positively related to awareness of silage preservation benefits, while livestock type was negatively associated with awareness of silage as a cost-effective feed option. Nevertheless, regression analysis demonstrated limited explanatory power, with yield per season identified as the only significant predictor of awareness. Thus, the alternative hypothesis (H1) is partially supported, as only certain demographic factors showed a significant relationship with awareness levels of silage production. Given the relatively small sample size, the findings should be interpreted cautiously and are primarily applicable to the study context, with limited generalisability beyond the study area.

Based on these findings, extension and development initiatives should prioritise experiential and participatory learning approaches to strengthen farmers' understanding of silage production. Field demonstrations, hands-on training programmes, and farmer-led trials should particularly target small-scale and non-ruminant farmers, who may have lower exposure to silage practices. Strengthening collaboration between government agencies, agricultural institutions, and local farmer networks is also recommended to enhance access to extension services. Future research with larger sample sizes is encouraged to improve the strength and external validity of the findings, thereby supporting broader application of silage production practices.

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7. CONFLICT OF INTEREST STATEMENT

The authors declare that this research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

8. AUTHORS' CONTRIBUTIONS

Aduni Adlin Mohammad: conceptualised the research idea, developed the conceptual framework, conducted the research and was responsible for data collection, analysis, and manuscript preparation and revision. **Nur Masriyah Hamzah:** designed the research, supervised the research process, guided the review and revisions, and approved the final manuscript for submission.

9. DECLARATION OF GENERATIVE AI AND AI-ASSISTED TECHNOLOGIES

This manuscript was developed with the assistance of ChatGPT (OpenAI) for language editing and improving the clarity of the manuscript. The tool supported the authors in correcting grammar, refining sentences, and enhancing the overall readability of the text. The authors reviewed, edited, and verified all scientific content, including the study design, data analysis, interpretation of results, and conclusions, and assume full responsibility for the final version submitted for publication.

10. DATA AVAILABILITY/SUPPLEMENTARY MATERIALS

The datasets used and/or analysed during the current study are available from the corresponding author on reasonable request.

11. ETHICS STATEMENT

Informed consent was obtained from all participants, and data anonymity was strictly maintained throughout the study.

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