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FARMERS' PERSPECTIVE ABOUT THE QUALITY, QUANTITY, AND PACKAGING EFFICIENCY OF PADDY STRAW MUSHROOMS (*Volvariella volvacea*): A STUDY IN DIFFERENT ZONES OF ODISHA

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Abstract: Nowadays, mushroom cultivation is one of India's most productive and profitable businesses and encourages employment. It is getting popular gradually because, in a short time, it converts farmers' hard work into a remarkable profit. Despite a favorable climate and low-cost labour, India has witnessed a lukewarm response in its growth. At present, India's total production of mushrooms is 0.13 million tons. The paddy straw mushrooms stand sixth among the mushrooms, biologically known as Volvariella volvacea. *These edible mushroom cultivated and consumed extensively in Asian continents all throughout. Often these are available in fresh conditions in the regions they are produced. Still, their quality, quantity, and packaging efficiency while reaching the customers is a significant concern for this sector's profitability and sustainable growth. India is reported a lukewarm response in its development, so has Odisha. A nondescript village, Kutenpadar in Odisha's Kalahandi, reputed for starvation death in the '80s, is now a role model for socio-economic growth and women empowerment. However, scientific understanding still has a long way to go! The current study was conducted via questionnaire among farmers in four zones of Odisha. To infer the zonal variation of Odisha in terms of quality, quantity, and packaging efficiency, rigorous statistical analysis such as significance test, ANOVA, and post hoc testing were used. The four zones have considerable differences in quality, quantity, and packaging efficiency, with packaging efficiency being the main reason.*

Keywords: Paddystraw Mushrooms, Volvariella volvacea, Packaging Efficiency, Sustainable Growth

1. INTRODUCTION

In most parts of India, paddy straw mushrooms are commonly produced and ranked sixth among the world's farmed mushrooms. It is one of the best types of mushrooms with right combination of flavour, delicacy, aroma, high protein content, vitamins, antioxidants, low fat, and minerals. The acceptability of this mushroom is no way less than the much popular white button mushroom. Mushroom consumption and demand have grown in popularity around the world in recent years, owing to its great nutritional and therapeutic value (*Mahapatra et al.*, (2020)). Nevertheless, due to high moisture content, water loss, respiration rate, enzymatic and microbiological activity, it has a limited shelf life after harvest in ambient circumstances (*Martine et al. 2002 & Amuthan et al. 1999*). All of these factors contribute to the paddy straw mushroom losing its attractiveness, quality, and lowering its economic value. (Nur Sakinah et al. 2019 & Mercado 1989). With the world's growing population and shrinking per capita arable land, as well as rapid urbanization and industrialization, environmental change, and a desire for high-quality, practical food varieties, it will be necessary to place a greater emphasis on optional horticulture and novel harvests, such as mushrooms. Despite the fact, it has its own disadvantage as it is characterized by a short shelf life owing to high moisture content, water loss and respiration rate.

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Our country is struggling in getting nutritional security these days and mushrooms stand as one such opportunity and a component that uses vertical space and helps address the issues of health, food quality, and environmental sustainability. There is a need to go forward with both mushroom production and consumption to meet the changing requirements of food items and make our eating regimen protein-rich. Paddy straw mushrooms contain 11.1% of fiber which is a remarkable amount according to scientific studies. Their low caloric, low sugar and high fibrous nature are an additional benefit notwithstanding different nutrients. Because of this specific nature, it can fix heart sicknesses, ulcers, diabetes, and so forth. Mushroom is the best energy source of nutrients, minerals, and protein. The fresh edible mushroom of one pound (454 g) contains 120 calories. (Murugesan. S *et al*., 2017). Since old time, mushroom has been included as a decision dish on numerous lofty tables. Mushrooms have a tantalizing and attractive flavour, and they are thought to be a viable protein source for filling the protein gap in the human body. In India, there are more veggie-loving people groups, which is why mushroom advocacy as a vegetable protein source among vegetations is critical. (Panneerselvam et al. 2009).

1.2. Literature review

The market size of mushrooms was estimated as USD 33,553.0 Million in 2019 and is predicted to reach USD 53,342.0 Million by 2027 (CAGR of 9.3% from 2021 to 2027), USD 95.24 billion by 2028 if expanding at a CAGR of 9.5%. The Lion's share is Asia-Pacific and expected growth is about a CAGR of 11.80% during 2021-27. In most parts of India, paddy straw mushroom is considered as a widely produced item. (*Dhalsamant et al., 2015*). Among all the farmed edible mushrooms, it is sixth in world's (*Khan et al.,* 2021)

A nondescript village, Kutenpadar in the district of Kalahandi in Odisha which was reputed for starvation death in the '80s, now is a role model for socio-economic growth and women empowerment. However, there is a long way to go with scientific insight.

Odisha currently has a total mushroom production of 12,334 tonnes per year, contributing to over 10 percent of the whole country's output. The straw mushroom is commercially grown for ten months a year (February-November), involving farmers who consider these as a secondary crop only in the state of Odisha. In different districts of Odisha, Mushrooms are cultivated because of the tropical climatic condition and the food habits of people. The rice cultivators of the waterfront agro-biological circumstance, specifically, have shown a realistic method for changing the lignocellulosic wastes straightforwardly into profoundly satisfactory, nutritious, and delightful nourishment for individuals. Odisha produces 8129 tonnes of straw mushroom per annum, contributing to 66 percent of the total mushroom production of the state (K.Mohapatra et. al, 2014). Cultivating mushrooms is one of the cheapest and economically viable options for the bioconversion of lignocellulosic waste material. Mushrooms can convert nutritionally low-value substances like paddy straw into valuable and nutritious human food. (Lenka, S et al.).

Efforts have been made to increase productivity by any means from the Government and other sectors in Mukhyamantri Krushi Udyog Yojana, Odisha Organic Farming Policy, and many more. To facilitate mushroom farming, the Government has formed a "Dedicated Agriculture Cabinet" for faster processes, sectorial growth & development. The National Research Centre for Mushrooms was established by the Indian Council of Agricultural Research (ICAR) in Chambaghat, Solan, to promote mushroom research. (Ahlawat, O.P. et al.; Panneerselvam et al. 2009). The state government facilitates mushroom cultivation on a commercial scale to ensure sustainable income generation, increase women farmers' income, fair use of available land and resources, create rural

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entrepreneurship, and livelihood support to landless farmers. Observing the potential scope in mushroom farming, thousands of SHG are acting as propagators in this field to enhance productivity, generate income, and increase the standard of living of the small and marginal farmers of the state.

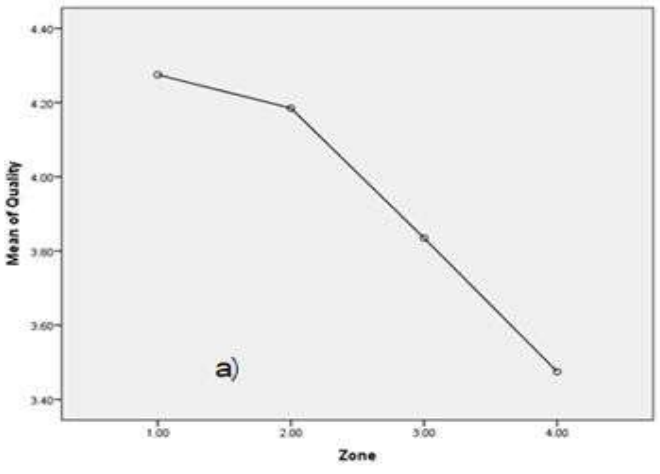
In this study, we analyzed the farmers' viewpoints about mushroom farming and its factors in four different zones of Odisha.

2. METHODOLOGY

A set of questionnaires has been prepared for qualitative analysis on quality, quantity, and packaging efficiency for different zones of Odisha (East=2, West=3, North=1, and South=4). We have denoted input variable as quality, quantity and packaging efficiency in scales in the range of 1-5 while 1 represents -poor, 2-average, 3-good and 4- very good and, 5-excellent for statistical analysis. 200 no. of farmers were interrogated and involved in this field of investigation from each zone who responded with different opinions about the quality, quantity, and packaging efficiency. All farmers were not satisfied with the packaging system as the causative factor for the quality degradation and quantity reduction in mushrooms. North zone farmers are convinced of the quality but disagree with the packaging. Farmers of the east zone are happy with the quality but don't agree with the quantity complained by the customers at the time of purchase. So farmers of this zone blamed the packaging system for being a disturbing element in the process. West zone farmers agreed to the quality moderately and provided positively to the quantity and were not all ready to accept the packaging system. Lastly, the south zone farmers moderately received the quality and quantity. Still, they didn't agree to the packaging of mushrooms which created a straightforward plot about the inefficiency of the packaging system of paddy straw mushrooms. The detailed responses of the farmers of four different zones are analyzed.

3. DATA ANALYSIS

3.1 Mean plot and Descriptive statistics: The mean plots were shown in Fig.1., Fig.2. and Fig.3. and the descriptive statistics, collected from 200 farmers from each 4 zones has been shown in Table-1.



[Figure 1. Mean plots of Quality (a) in 4 Zones]

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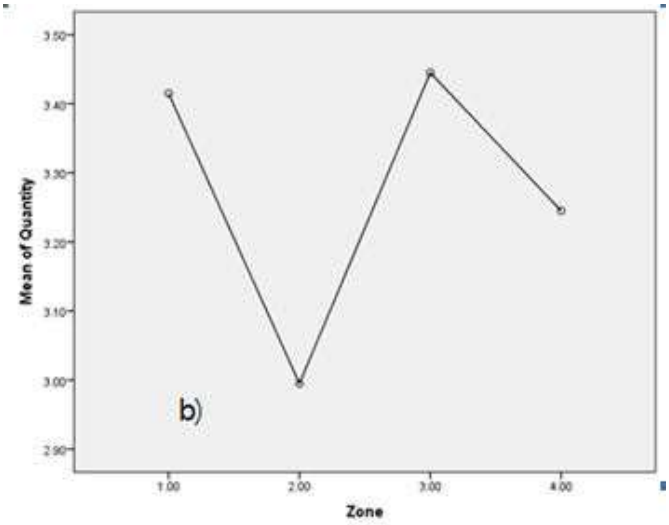
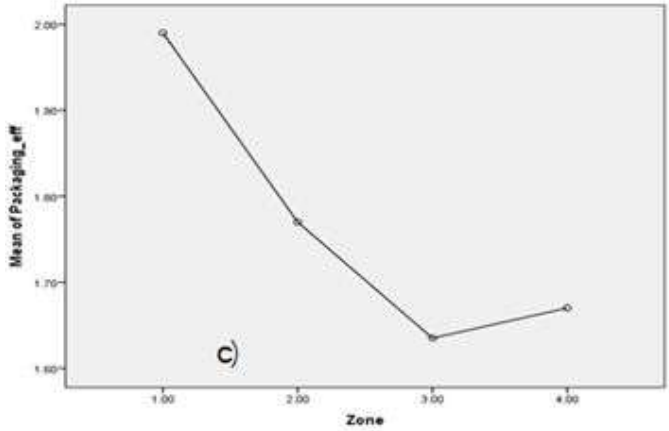


[Figure 2. Mean plots of Quantity (b) in 4 Zones



[Figure 3. Mean plots of Packaging Efficiency (c) in 4 Zones]

Table-1: (Descriptive statistics of 200 farmers each of 4 zones)

		N	Mean	Std. Deviation	Std. Error	95% Confidence Interval for Mean		Between-Component Variance
						Lower Bound	Upper Bound	
Quality	1.00	200	4.2750	1.28359	.09076	4.0960	4.4540	
	2.00	200	4.1850	1.24439	.08799	4.0115	4.3585	

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	3.00		200	3.8350	1.34791	.09531	3.6470	4.0230	
	4.00		200	3.4750	.78258	.05534	3.3659	3.5841	
	Total		800	3.9425	1.22518	.04332	3.8575	4.0275	
	Model	Fixed Effects			1.18590	.04193	3.8602	4.0248	
		Random Effects				.18245	3.3618	4.5232	.12613
	1.00		200	3.4150	1.03350	.07308	3.2709	3.5591	
	2.00		200	2.9950	.92697	.06555	2.8657	3.1243	
	3.00		200	3.4450	.97557	.06898	3.3090	3.5810	
	4.00		200	3.2450	1.21340	.08580	3.0758	3.4142	
Quantity	Total		800	3.2750	1.05630	.03735	3.2017	3.3483	
	Model	Fixed Effects			1.04301	.03688	3.2026	3.3474	
		Random Effects				.10320	2.9466	3.6034	.03716
	1.00		200	1.9900	.95101	.06725	1.8574	2.1226	
	2.00		200	1.7700	.78753	.05569	1.6602	1.8798	
	3.00		200	1.6350	.62749	.04437	1.5475	1.7225	
	4.00		200	1.6700	.68075	.04814	1.5751	1.7649	
Packaging_eff	Total		800	1.7663	.78254	.02767	1.7119	1.8206	
	Model	Fixed Effects			.77165	.02728	1.7127	1.8198	
		Random Effects				.07988	1.5120	2.0205	.02255

From the above Table-1, the mean and standard deviation values of the study on quality, quantity, and packaging efficiency with their variations are outlined as follows:

3.1.1 Quality: 1 -North (4.2750: (Very good to Excellent) > 2-East (4.1850: (Very good to Excellent))> 3-West (3.8350: (Close to Very good)> 4- South (3.4750: (Good to Very Good). The highest quality means were responded from the north zone and most minor from the South. The respondent variations were less in Zone 4- South (Std. Deviation.78258) and highest in 3-West (Std. Deviation=1.34791). Farmers of the north zone, when faced with the questions, answered about their genuineness in the production process, packaging materials, and process for storage. They argued their products to be authentic and excellent in quality, whereas they are a bit doubtful about the accuracy in quantity supplied by them and received from other suppliers. East zone farmers also agreed to the goodness of the quality

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provided by them to the intermediaries and other parties. West and South zone farmers responded positively to supplying quality products from their side.

3.1.2 ***Quantity:*** 3-West (3.4450)> 1 –North (3.4150)> 4- South (3.2450)>2-East (2.9950). The respondent variations were less in Zone 2- East (Std. Deviation=.92697) and highest in zone 4-South (Std. Deviation=1.21340). Farmers of the West zone replied about the perfection of quantity, and they believed well about the quality of products being produced and supplied by them. Farmers of other zones also positively responded to quality, but they are not sure about it for many reasons. They were purchasing in a hurry, not having a planned purchase, good look, and many more.

3.1.2 Packaging Efficiency: 1-North (1.9900)>2-East (1.7700)> 4-South (1.6700)> 3-West (1.6350). The respondent variations were less in Zone 3- West (Std. Deviation=.62749) and highest in Zone 1-North (Std. Deviation=.95101). The packaging quality was responded badly instead. They were below 2, i.e., poor to average. Behind this, many factors may be possible; maybe the farmers were sure about their quality and quantity but seemed to blame the packaging efficacy as they received poor comments from the intermediate sellers and users side. There may be ignorance of the farmers about the right kind of packaging to be used just after harvesting the produce. Scientifically many factors may also be responsible for spelling about the efficient packaging of the harvested products, such as transpiration, delay in packaging, supplying and selling, and sometimes change in climate causing deterioration in the product in the form of colour change and weight loss.

3.2 ANOVA and Post-Hoc test:

The ANOVA test results were described in Table 2.

Table 2: (Anova test results)

		Sum of Squares	df	Mean Square	F	Sig.
Quality	Between Groups	79.895	3	26.632	18.937	**.000**
	Within Groups	1119.460	796	1.406		
	Total	1199.355	799			
Quantity	Between Groups	25.560	3	8.520	7.832	**.000**
	Within Groups	865.940	796	1.088		
	Total	891.500	799			
Packaging_eff	Between Groups	15.314	3	5.105	8.573	**.000**
	Within Groups	473.975	796	.595		
	Total	489.289	799			

The significant values indicated in the right of the table were conclusive enough that between and among the four zones showed a significant difference in grading of quality, quantity & packaging efficiency. Quantity may not be an issue

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followed by packaging efficiency. However, the quality of the material seems to be of concern for customers though rated well by the farmers. Here, farmers may be unaware of the quality evaluated at the point of sale, or customers' feedback was highly dependent upon their perception or attitude to bargain. But, there should not be a second opinion that packaging efficiency that ensures prolonged self-life with preserved ingredients plays a vital role throughout the supply chain. The post-hoc test results from SPSS are outlined in table 3.

Table 3: (Post-hoc test results (The mean difference is significant at the 0.05 level)

Dependent Variable		(I) Zone	(J) Zone	Mean Difference (I-J)	Std. Error	Sig.	95% Confidence Interval	
							Lower Bound	Upper Bound
			2.00	.09000	.11859	.873	-.2153	.3953
		1.00	3.00	.44000*	.11859	**.001**	.1347	.7453
			4.00	.80000*	.11859	**.000**	.4947	1.1053
			1.00	-.09000	.11859	.873	-.3953	.2153
		2.00	3.00	.35000*	.11859	.017	.0447	.6553
			4.00	.71000*	.11859	**.000**	.4047	1.0153
	Tukey HSD		1.00	-.44000*	.11859	**.001**	-.7453	-.1347
		3.00	2.00	-.35000*	.11859	.017	-.6553	-.0447
			4.00	.36000*	.11859	.013	.0547	.6653
			1.00	-.80000*	.11859	**.000**	-1.1053	-.4947
		4.00	2.00	-.71000*	.11859	**.000**	-1.0153	-.4047
			3.00	-.36000*	.11859	.013	-.6653	-.0547
Quality			2.00	.09000	.11859	1.000	-.2237	.4037
		1.00	3.00	.44000*	.11859	**.001**	.1263	.7537
			4.00	.80000*	.11859	**.000**	.4863	1.1137
			1.00	-.09000	.11859	1.000	-.4037	.2237
		2.00	3.00	.35000*	.11859	.020	.0363	.6637
			4.00	.71000*	.11859	.000	.3963	1.0237
	Bonferroni		1.00	-.44000*	.11859	.001	-.7537	-.1263
		3.00	2.00	-.35000*	.11859	.020	-.6637	-.0363
			4.00	.36000*	.11859	.015	.0463	.6737
			1.00	-.80000*	.11859	.000	-1.1137	-.4863
		4.00	2.00	-.71000*	.11859	.000	-1.0237	-.3963
			3.00	-.36000*	.11859	.015	-.6737	-.0463
Quantity	TukeyHSD	1.00	2.00	.42000*	.10430	**.000**	.1515	.6885

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			3.00	-.03000	.10430	.992	-.2985	.2385
			4.00	.17000	.10430	.362	-.0985	.4385
			1.00	-.42000*	.10430	**.000**	-.6885	-.1515
		2.00	3.00	-.45000*	.10430	**.000**	-.7185	-.1815
			4.00	-.25000	.10430	.078	-.5185	.0185
			1.00	.03000	.10430	.992	-.2385	.2985
		3.00	2.00	.45000*	.10430	**.000**	.1815	.7185
			4.00	.20000	.10430	.221	-.0685	.4685
			1.00	-.17000	.10430	.362	-.4385	.0985
		4.00	2.00	.25000	.10430	.078	-.0185	.5185
			3.00	-.20000	.10430	.221	-.4685	.0685
			2.00	.42000*	.10430	**.000**	.1441	.6959
		1.00	3.00	-.03000	.10430	1.000	-.3059	.2459
			4.00	.17000	.10430	.621	-.1059	.4459
			1.00	-.42000*	.10430	**.000**	-.6959	-.1441
		2.00	3.00	-.45000*	.10430	**.000**	-.7259	-.1741
			4.00	-.25000	.10430	.101	-.5259	.0259
	Bonferroni		1.00	.03000	.10430	1.000	-.2459	.3059
		3.00	2.00	.45000*	.10430	**.000**	.1741	.7259
			4.00	.20000	.10430	.333	-.0759	.4759
			1.00	-.17000	.10430	.621	-.4459	.1059
		4.00	2.00	.25000	.10430	.101	-.0259	.5259
			3.00	-.20000	.10430	.333	-.4759	.0759
			2.00	.22000*	.07717	.023	.0213	.4187
		1.00	3.00	.35500*	.07717	**.000**	.1563	.5537
			4.00	.32000*	.07717	**.000**	.1213	.5187
			1.00	-.22000*	.07717	.023	-.4187	-.0213
		2.00	3.00	.13500	.07717	.299	-.0637	.3337
			4.00	.10000	.07717	.566	-.0987	.2987
	Tukey HSD		1.00	-.35500*	.07717	**.000**	-.5537	-.1563
		3.00	2.00	-.13500	.07717	.299	-.3337	.0637
Packaging_eff			4.00	-.03500	.07717	.969	-.2337	.1637
			1.00	-.32000*	.07717	**.000**	-.5187	-.1213
		4.00	2.00	-.10000	.07717	.566	-.2987	.0987
			3.00	.03500	.07717	.969	-.1637	.2337
			2.00	.22000*	.07717	.027	.0159	.4241
		1.00	3.00	.35500*	.07717	**.000**	.1509	.5591
	Bonferroni		4.00	.32000*	.07717	**.000**	.1159	.5241
		2.00	1.00	-.22000*	.07717	.027	-.4241	-.0159

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		3.00	.13500	.07717	.484	-.0691	.3391
		4.00	.10000	.07717	1.000	-.1041	.3041
		1.00	-.35500*	.07717	**.000**	-.5591	-.1509
	3.00	2.00	-.13500	.07717	.484	-.3391	.0691
		4.00	-.03500	.07717	1.000	-.2391	.1691
		1.00	-.32000*	.07717	**.000**	-.5241	-.1159
	4.00	2.00	-.10000	.07717	1.000	-.3041	.1041
		3.00	.03500	.07717	1.000	-.1691	.2391

Interpretation of Results

QUALITY (Bonferroni & Tukey HSD: Major/ significant difference in quality was found between zone-1 (NORTH) with zone 3(WEST) and zone - 4(South) and 2(East) with 4(South). There is a major/ significant difference between zone-2 (EAST) with zone 4(South). 2~4 and 1~4 are more significant than 1~3.

QUANTITY (Bonferroni & Tukey HSD): 1~2, 2~3: Major/significant difference in quantity was found between zone 1(NORTH) with zone 2(EAST) and zone 2(East) and with Zone 3(WEST)

PACKAGING Efficiency (Bonferroni & Tukey HSD):1~3, 1~4Major/significant difference in Packaging efficiency was found between zone 1(North) with Zone-3(West) and zone-4(south).

4. CONCLUSION

There exists a significant difference in quality, quantity & packaging efficiency among all four zones of Odisha. Quality grading in descending order was 1 -North (4.2750: (Very good to Excellent) > 2-East (4.1850: (Very good to Excellent))> 3-West (3.8350: (Close to Very good)> 4- South (3.4750: (Good to Very Good). For Quantity: 3-West (3.4450)> 1–North (3.4150)> 4-South (3.2450)>2-East (2.9950).Packaging Efficiency got poor grading in all zones from 1-2 range (poor to average); i.e., 1-North (1.9900 :)> 2-East (1.7700 :)> 4-South (1.6700 :)> 3-West (1.6350 :). The respondent variations were less in Zone 3- West (Std. Deviation=.62749) and highest in Zone 1-North (Std. Deviation=.95101)

We have tried to bring the reasons that create dissatisfaction among the farmers and ordinary people about these three dimensions: quality, quantity, and packaging efficiency. The highest number of farmers responded positively to the quality in the north zone, but they have little knowledge on how to store it for selling by keeping its quality and quantity in the best manner. The quantity is also a concern, as badly mentioned by eastern growers; this may be due to the fact that the paddy straw mushrooms lose moisture due to several reasons, e.g., temperature variation, bacterial growth, open contact with air, and careless storage at the intermediary's points. It is evident that the packaging issues play a crucial role and

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must be taken care of as a remarkable amount is wasted before the delicious product reaches the table. In many cases, the farmers are sure about their quality and quantity, but it has finally been decided when it comes to sales or when food is served. So more research on increasing the packaging efficiency is demanded better customer satisfaction.

At the producer's end, if the stakeholders and government are concerned about supplying quality packaging, then the farmers will earn and grow, and the state will earn a remarkable self-image in the state and national consumer market. Eventually, the socio-economic and sustainable growth of the sector would be ensured, and the end-users will enjoy a tasty, qualitative diet.

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