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Evaluating Arecanut Production Performance: A Comparative Analysis of Tumcos (Tota Utpannagala Marata Sahakara Sangha Niyamit) Members and Non-Members in Davanagere, Karnataka, India

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Arecanut (*Areca catechu*), commonly known as betel nut, is a vital commercial crop in India, with Karnataka being the leading producer. Despite its economic significance, arecanut growers encounter various challenges, including increasing input costs, labor shortages, and limited knowledge of pest and disease management. Cooperatives like TUMCOS (Tota Utpannagala Marata Sahakara Sangha Niyamit) play a crucial role in supporting farmers by providing essential resources, training programs, and market linkages. This study assesses the production performance of arecanut growers by comparing TUMCOS members and non-members in Davanagere district, Karnataka. Conducted across five TUMCOS branch areas during 2020-2021, the study employed an ex-post facto research design. A total of 120 farmers (60 TUMCOS members and 60 non-members) were selected using a simple random sampling technique. Data were collected through structured personal interviews and analyzed using statistical tools to evaluate production performance, knowledge levels, and adoption rates of recommended agricultural practices. Findings indicate that TUMCOS members exhibited superior performance compared to non-members, with over two-fifths (41.66%) of members achieving high production performance, whereas more than half (53.34%) of non-members fell into the medium-performance category. Similarly, knowledge levels were higher among members, with 41.66% possessing high knowledge compared to only 25.00% of non-members. This disparity was attributed to regular training sessions, extension services, and access to quality inputs facilitated by TUMCOS. Additionally, the adoption of recommended practices, particularly in irrigation methods, pest management, and intercropping, was more prevalent among members. The study underscores the significance of cooperative membership in enhancing farmers' technical expertise and resource availability, thereby improving productivity. Strengthening cooperative networks and expanding extension services can help bridge the gap between members and non-members, promoting sustainable arecanut farming. Addressing labor shortages, improving disease management knowledge, and ensuring access to high-quality seedlings are critical areas for future intervention.

Keywords: Extension contact; farming experience; production performance; TUMCOS.

1. INTRODUCTION

Arecanut *(Areca catechu)*, commonly known as betel nut, supari or adike, is a palm tree species from the Arecaceae family. The nut is rich in polyphenols, fats, polysaccharides, fiber and protein. Tannins, a by-product from immature nuts, are valuable in various industries for dyeing textiles, tanning leather, as a food colouring agent and as a mordant for producing diverse shades with metallic salts. The nuts contain 8–12% fat, which can be extracted and used in confectionery. In the 4th century AD, Vagbhata praised the medicinal qualities of arecanut, noting its efficacy against conditions such as leucoderma, leprosy, cough, epilepsy, worms, anaemia, and obesity. Arecanut is a highly commercial crop, offering substantial health and economic benefits to both farmers and consumers. It serves as a primary income source for many farmers in India.

India leads the world in arecanut production, contributing 8.53 lakh tonnes, which represents 52.30% of the global output. Karnataka is the top producer within the country, covering an area of 2.79 lakh hectares, and accounting for 57.85 % of India's total arecanut cultivation. Among Karnataka's districts, Shivamogga ranks first in both area (92,241 hectares) and production (169,305 tonnes) during 2018-2019, followed by Dakshina Kannada and Davanagere (Directorate of Economics and Statistics, Government of Karnataka, 2023). In Davanagere, the Malnad region and traditional zones such as Channagiri, Honnali, Davanagere, and Harihar are particularly well-suited for large-scale arecanut cultivation.

Arecanut growers in India, particularly in Karnataka, face a range of challenges that significantly affect their productivity and overall performance. A primary issue is the escalating cost of cultivation, primarily driven by the rising prices of essential inputs such as fertilizers, pesticides, and irrigation resources. This financial strain is further intensified by the scarcity of labor, which has become a critical concern due to urban migration and alternative employment opportunities drawing workers away from agriculture. Labour shortages lead to delays in essential farming activities like planting, weeding, and harvesting, while increasing wage rates

make it harder for farmers to sustain profitability (Nayak et al., 2023).

Another major challenge is the limited knowledge among farmers about effective pest and disease management practices. Pests such as red palm weevils and diseases like koleroga (fruit rot), Hidimundige disease are significant threats, often causing extensive damage to crops and reducing yields. Many farmers lack awareness of preventive measures and modern treatment techniques, which exacerbates these problems and results in considerable yield losses (Sharma & Kumar, 2023). Studies reveal that traditional practices and delayed interventions are often inadequate to address these growing issues effectively (Rajesh et al., 2022).

Studying the performance of arecanut growers is crucial to identify the specific factors influencing productivity and profitability and to develop targeted interventions for improvement. Performance assessments can help in understanding regional disparities in cultivation practices, resource utilization and technological adoption. Recent research emphasizes that a comprehensive evaluation of farmers' practices, challenges, and economic outcomes provides valuable insights for policy formulation and capacity-building initiatives (Bhaskar et al., 2022). Moreover, such studies play a key role in guiding agricultural extension services to design customized training programs and support systems that align with the needs of growers (Kumar & Rao, 2023). Therefore, the present study has been designed to examine the critical role played by the marketing cooperative in enhancing the performance of arecanut growers. It aims to compare the production performance of members and non-members of TUMCOS in Davanagere district, Karnataka (Preeti, 2024).

2. MATERIALS AND METHODS

The study was carried out in Davanagere district of Karnataka during 2020-2021. The area was purposefully chosen due to its high production and productivity of arecanut, as well as being the headquarters of TUMCOS. The research followed an ex-post facto design. TUMCOS operates eight branches across four districts in Karnataka, with five branches—Tavarekere, Santebennur, Honnali, Sagarapete, and Channagiri—located in Davanagere district, which were selected for the study. From each branch, 12 TUMCOS members and 12 non-members were randomly selected, making a total of 24 farmers per branch. This brought the total sample size to 120 farmers across the five branches. Data were collected through personal interviews using a structured interview schedule.

3. RESULTS AND DISCUSSION

3.1 Performance of Member and Non-member Arecanut Growers of TUMCOS

Table 1 provides the information on production performance of member and non-member arecanut growers of TUMCOS.

3.1.1 Production performance

Table 1 reveals that over two-fifths (41.66 %) of member arecanut growers fall under the high production performance category, while 30.00 % exhibit medium performance and 28.34 % are categorized as low performers. In contrast, more than half (53.34 %) of non-member growers are classified under medium production performance, followed by 31.66 % in the low category, and only 15.00 % in the high-performance group. Overall, 41.66 % of all arecanut growers achieved medium production performance, with 30.00 % categorized as low performers and 28.34 % as high performers.

The trend among TUMCOS members is skewed toward high to medium production, while non-members show a pattern of medium to low performance. The overall trend among all growers leans toward medium to low performance. This variation could be attributed to the greater knowledge and support members receive through farmer meetings, seminars, demonstrations and material input services offered by TUMCOS, which help boost production. Conversely, non-members, who lack exposure to technical production practices, may show a lower performance trend. Additionally, factors such as education, farming experience, annual income, extension contact, eagerness to gather information on farming, and social participation are likely to have a significant influence on growers' knowledge and adoption of recommended practices, ultimately impacting their production outcomes. These findings are consistent with Deepika, (2015).

3.1.2 Overall knowledge of member and non-member arecanut growers of TUMCOS

Table 2 indicates the overall knowledge of member, non-member arecanut growers of TUMCOS. In terms of member arecanut growers,

less than half (41.66 %), less than one-third (30.00 %) and more than one-fifth (28.34 %) of the arecanut growers belonged to high, medium and low knowledge category, respectively. Among the non-member arecanut growers, more than two-fifth (40.00 %), more than one-third (35.00 %) and one-fifth (25.00 %) of arecanut growers belonged to medium, low and high knowledge category, respectively. One third (35.00 %) of the total arecanut growers belonged to medium knowledge category. Less than one-third (33.33 %) and more than one fourth (31.67 %) of total arecanut growers belonged to high and low knowledge category. The trend observed among member arecanut growers was found to be high to medium, whereas it was found that the trend was medium to low among non-members. However, the trend followed by overall arecanut growers was medium to high category. One of the likely causes of the aforesaid trend among members could be improved knowledge as a result of a series of farmer meetings, seminars, demonstrations, and material input services given under TUMCOS to increased production. The findings are in line with Navasakthi, (2005).

3.1.3 Practice wise knowledge level of member and non-member arecanut growers of TUMCOS

Table 3 indicates the practice wise knowledge level of member and non-member arecanut growers.

Varieties: The results with respect to recommended varieties, 85.83 per cent of overall arecanut growers had incorrect knowledge about recommended areca nut varieties. This could be attributed to a lack of awareness among areca farmers about improved arecanut varieties as well as a lack of timely availability and sufficient quantities of recommended variety seedlings for main field transplantation in near vicinity.

Nursery management: In terms of overall arecanut growers, more than half (53.33 %) had incorrect knowledge about age of mother plant for selection of nuts. More than three-fourth (76.67 %) had correct knowledge about dimension of polybag required for raising seedling. More than half (55.00 %) had incorrect knowledge about ratio of polybag mixture. The majority of the farmers had average knowledge about nursery management. Probable reason might be that they always go for buying of seedlings from established nursery and they lack experience in nursery management.

Planting in main filed: The results regard to planting in main field depicts that among overall arecanut growers 72.50 had correct knowledge and 27.50 per cent had incorrect knowledge about age of seedling for transplanting in main field. The likely reason is that appropriate age of seedling for transplanting to main field is the one time strategic investment, which determines the longevity of the plantation, as over aged seedlings are susceptible of wind damages, while under aged seedlings are susceptible of pest and climate vagaries in main field.

Spacing and direction of planting in main field: In reference to overall arecanut growers, more than three-fourth (78.33 %) of arecanut growers had correct knowledge about proper spacing. Less than three-fourth (72.50 %) had correct knowledge about recommended pit size. More than three-fourth (71.67 %) had correct knowledge about pit filing. More than half (55.83 %) had correct knowledge about direction of planting. Due to their farming experience, the majority of arecanut growers had fairly good knowledge of recommended spacing, pit size and pit filling. Less than half of the growers had incorrect knowledge of planting direction, which could be due to a lack of awareness about the importance of planting direction in avoiding stem splitting due to sun scorching.

Manures and fertilizers: In regard to overall arecanut growers, more than three-fifth (62.50 %) of arecanut growers had correct knowledge about quantity of FYM application. 65.00 per cent had correct knowledge about recommended quantity of green manures. Exact three-fifth (60.00 %) of arecanut growers had correct knowledge about application of chemical fertilizers. Less than three-fifth (58.33 %) had correct knowledge about band application of fertilizers. More than half of arecanut growers had correct knowledge about quantity and application of manures and fertilizer application. This may attribute due to their medium social participation, extension contact and mass media participation.

Water management: In regard to overall arecanut growers, more than three-fourth (82.50 %) of them had correct knowledge about method of irrigation. More than half (62.50 %) of them had correct knowledge about irrigation interval. The majority of arecanut planters had correct knowledge of recommended irrigation methods, but nearly half of arecanut growers had incorrect knowledge of irrigation intervals. This could be due to a lack of awareness about

critical irrigation periods, as well as a lack of water availability during the summer, making it difficult to maintain proper irrigation interval timings.

Intercropping: Among overall arecanut growers, majority (95.00 %) of them had correct knowledge about intercropping with banana, whereas less than three-fourth (72.50 %) of them had correct knowledge in regard to intercropping of arecanut with pepper. Majority of them had correct knowledge about intercrops that should be raise with the arecanut crop. Possible reasons could be, intercrops give farmers with additional income and allow them to efficiently utilise space between areca plants.

Pest, disease and disorder: In regard to overall arecanut growers, more than half (60.83 %) of them had correct knowledge about mites management, nearly 52.50 per cent of them had correct knowledge about spindle bug management whereas 59.17 per cent of them had incorrect knowledge about fruit rot management. However, less than three-fourth (65.00 %) of them had incorrect knowledge about foot rot management. Less than three-fourth (67.50 %) of the growers had correct knowledge about nut splitting management, 54.17 per cent of them had correct knowledge about nut dropping management. Because of their understanding of the visible signs and severity of the pest's incidence in this location, the majority of the growers had correct knowledge about mites and spindle bug control in arecanut. Due to the low occurrence of disease in this location, the majority of arecanut planters had a basic understanding of fruit rot and foot rot control. More than half of arecanut growers were aware of important disorders such as nut dropping and nut splitting, which have a substantial impact on the crop's final output and quality. Results are supported by the study conducted by Mohanraj et al., (2021).

Harvesting and processing: Among overall arecanut growers, slightly less than three-fourth (74.17 %) of them had correct knowledge about ideal month of harvesting, whereas 72.50 per cent of them had correct knowledge about ideal stages of nuts for harvesting. 67.50 per cent of them had correct knowledge about ideal yield of dry nuts. Majority of arecanut growers had correct knowledge about ideal month for harvesting, ideal nut stage for processing and ideal yield of dry nuts. Probable reasons may be due, ideal month and ideal stage of harvesting decides the final quality and quantity of dry nuts, harvesting before ideal month leads to immature harvesting or over ripened yellow nuts harvesting affects the quality of dry nut. Final yield of crop will be depend on knowledge and adoption of appropriate management practices by the areca growers.

3.1.4 Overall adoption level of member and non-member arecanut growers of TUMCOS

Table 4 reveals the overall adoption of member, non-member arecanut growers of TUMCOS. Among the member arecanut growers, two-fifth (40.00 %), less than one –third (31.66 %) and 28.34 per cent of the arecanut growers belonged to high, medium and low adoption category, respectively. In terms of non-member arecanut growers, less than half (43.34 %), more than two-fifth (41.66 %) and more than one-seventh (15.00 %) of the arecanut growers belonged to medium, low and high adoption category, respectively. Whereas, less than two-fifth (37.50 %) of overall areca growers belongs to medium adoption category. More than one-third (35.00 %) and more than one-fourth (27.50 %) of the areca growers belongs low and high adoption categories. The trend among member arecanut growers was found to be high to medium, but the trend among non-members was found to be medium to low. However overall arecanut growers followed a medium to low category trend. Technical understanding, backed up by the accessibility of obtaining material inputs, will have a significant impact on adoption. As a member of TUMCOS, they can acquire essential material inputs at reasonable costs and with guaranteed quality on time is one of the main reasons for the high adoption rate among member arecanut growers. The adoption rate of non-member arecanut growers revealed the trend to be medium to low may be due to less extension contact, social participation, and scientific orientation, as well as a lack of exposure to awareness programmes and problems in obtaining material inputs.

3.1.5 Practice wise adoption level performance of member and non-member arecanut growers of TUMCOS

The results in Table 5 depict the practice wise adoption level of member and non-member arecanut growers of TUMCOS.

Table 1. Performance of member and non-member arecanut growers of TUMCOS

Sl. No.	Indicators	Category	Members arecanut growers (n_1=60)		Non-members arecanut growers (n_2=60)		Overall arecanut growers (n=120)	
			f	%	f	%	f	%
1	Production performance Mean = 60.11 S.D.= 24.04	Low (<48.09)	17	28.34	19	31.66	36	30.00
		Medium (48.09-72.13)	18	30.00	32	53.34	50	41.66
		High (>72.13)	25	41.66	09	15.00	34	28.34

f - Frequency, % - per cent

Table 2. Overall knowledge level of member and non-member arecanut growers of TUMCOS

Sl. No.	Indicators	Category	Member arecanut growers (n_1=60)		Non-member arecanut growers (n_2=60)		Overall arecanut growers (n=120)	
			f	%	f	%	f	%
1	Overall knowledge Mean: 32.91 S.D. :18.38	Low (< 23.72)	17	28.34	21	35.00	38	31.67
		Medium (23.72-42.10)	18	30.00	24	40.00	42	35.00
		High (>42.10)	25	41.66	15	25.00	40	33.33
		Total	60	100.00	60	100.00	120	100.00

f - Frequency, % - per cent

Table 3. Practice wise knowledge level of member and non-member arecanut growers of TUMCOS

Sl. No.	Recommended practices	Member arecanut growers (n_1=60)				Non-member arecanut growers (n_2=60)				Overall arecanut growers (n=120)			
		Correct knowledge		Incorrect knowledge		Correct knowledge		Incorrect knowledge		Correct knowledge		Incorrect knowledge	
		f	%	f	%	f	%	f	%	f	%	f	%
I	Varieties (Sirsi-1, Mangala, Channagiri tall)	12	20.00	48	80.00	05	08.33	55	91.67	17	14.17	103	85.83
Nursery management													
a	Age of mother plant for selection of nuts (15-25 years)	32	53.34	28	46.66	24	40.00	36	60.00	56	46.67	64	53.33
b	Dimension of polybag required for raising seedling (25X15 cm)	47	78.34	13	21.66	45	75.00	15	25.00	92	76.67	28	23.33
C	Ratio of polybag mixture (3 part soil: 1part FYM: 1 part sand)	31	51.66	29	48.34	23	38.32	37	61.68	54	45.00	66	55.00
Planting in main field													
a	Age of seedling for transplanting in main field (12-18 months/at 5 leaves stage)	48	80.00	12	20.00	39	65.00	21	35.00	87	72.50	33	27.50
Spacing and direction of planting in main field													
a	Spacing (2.7m X2.7 m)	51	85.00	09	15.00	43	71.66	17	28.34	94	78.33	26	21.67
b	Pit size (75X75X75cm/90X90X90 cm)	46	76.63	14	23.34	41	71.67	19	31.66	87	72.50	33	27.50
C	Pit filling (Top soil to bottom+15-20 Kg FYM+ bottom soil on top)	49	81.66	11	18.34	37	61.68	23	38.32	86	71.67	34	28.33

Sl. No.	Recommended practices	Member arecanut growers (n_1=60)				Non-member arecanut growers (n_2=60)				Overall arecanut growers (n=120)			
		Correct knowledge		Incorrect knowledge		Correct knowledge		Incorrect knowledge		Correct knowledge		Incorrect knowledge	
		f	%	f	%	f	%	f	%	f	%	f	%
d	Direction of planting (North-south & 35^0 towards south-west)	38	63.34	22	36.66	29	48.34	31	51.66	67	55.83	53	44.17
Manures and fertilizers													
a	FYM (20Kg/palm/year)	43	71.66	17	28.34	32	53.34	28	46.66	75	62.50	45	37.50
b	Green manures and quantity (Sunhemp/Dahincha/Cowpea, 20Kg/acre)	41	68.33	19	31.66	37	61.68	23	38.32	78	65.00	42	35.00
c	Chemical fertilizer (100g N, 40g P, 140g K)	43	71.66	17	28.34	39	65.00	21	35.00	72	60.00	38	40.00
d	Method and placing of fertilizer pre and post monsoon at 1.5-3 feet apart from trunk (band application)	39	65.00	21	35.00	31	51.66	28	46.66	70	58.33	50	41.67
Water management													
a	Method of irrigation (drip irrigation)	51	85.00	09	15.00	48	80.00	12	20.00	99	82.50	21	17.50
b	Irrigation interval	41	71.67	19	31.66	34	56.67	26	43.33	75	62.50	45	37.50
Intercropping													
a	Arecanut + Banana	60	100.00	00	00.00	54	90.00	06	10.00	114	95.00	06	05.00
B	Arecanut + Pepper	49	81.66	11	18.34	38	63.34	22	36.66	87	72.50	33	27.50
Pest, disease and disorder													
a	Mites management (Dicofol 2.5ml/lit or Dimethoate 1.5ml/lit)	42	70.00	18	30.00	31	51.66	29	48.34	73	60.83	47	39.17
b	Spindle bug management (Quinolphos 2ml/lit or Monocrotophos 1.5ml/lit)	37	61.68	23	38.32	26	43.33	34	56.67	63	52.50	57	47.50
c	Fruit rot/ Koleroga management (1 % Bordeaux or 3g COC or 2g Metalaxyl + Mancozeb/lit of water before rainy season)	28	46.66	32	53.34	21	35.00	39	65.00	49	40.83	71	59.17
d	Foot rot/ Anaberoga management cultural practices + Drenching of propiconazole (1mi/lit) at 15-20 lit/palm/ Neem cake application of 2Kg/palm/year.	24	40.00	36	60.00	18	30.00	42	70.00	42	35.00	78	65.00
e	Nut splitting / Andoduku (Borax spray @ 2g/lit or 20g of boron/palm as soil application)	42	70.00	18	30.00	39	65.00	21	35.00	81	67.50	39	32.50
f	Nut dropping (Proper drainage and RDF.)	37	61.68	23	38.32	28	46.66	32	53.34	65	54.17	55	45.83
Harvesting and processing													
a	Ideal month for harvesting (July-Dec)	48	80.00	12	20.00	41	71.67	19	31.66	89	74.17	31	25.83
b	Ideal stage of nuts for harvesting (6-7 months)	49	81.66	11	18.34	38	63.34	22	36.66	87	72.50	33	27.50
c	Ideal yield of dry nuts (800-1000 Kg/acre)	42	70.00	18	30.00	39	65.00	21	35.00	81	67.50	39	32.50

f - Frequency, % - per cent

Table 4. Overall adoption level of member and non-member arecanut growers of TUMCOS

Indicators	Category	Member arecanut growers (n_1=60)		Non-member arecanut growers (n_2=60)		Overall arecanut growers (n=120)	
		f	%	f	%	f	%
Overall adoption	Low (<24.37)	17	28.34	25	41.66	42	35.00
Mean: 27.20	Medium (24.37-30.03)	19	31.66	26	43.34	45	37.50
S.D: 5.66	High (>30.03)	24	40.00	09	15.00	33	27.50
	Total	60	100.00	60	100.00	120	100.00

f - Frequency, % - per cent

Table 5. Practice wise adoption level performance of member and non-member arecanut growers of TUMCOS

Sl. No.	Recommended practices	Member arecanut growers (n_1=60)						Non-member arecanut growers (n_2=60)						Overall arecanut growers (n=120)					
		Full adoption		Partial adoption		No adoption		Full adoption		Partial adoption		No adoption		Full adoption		Partial adoption		No adoption	
		f	%	f	%	f	%	f	%	f	%	f	%	f	%	f	%	f	%
I	Varieties (Sirsi-1, Mangala, Channagiri tall)	05	08.33	00	00.00	55	91.67	00	00.00	00	00.00	60	100.00	05	04.17	00	00.00	115	95.83
Nursery management																			
a	Age of mother plant for selection of nuts (15-25 years)	08	13.33	12	20.00	40	66.67	05	8.33	15	25.00	40	66.67	13	10.83	27	22.50	80	66.67
b	Dimension of polybag required for raising seedling (25X15 cm)	19	31.66	00	00.00	41	71.67	21	35.00	00	00.00	39	65.00	40	33.33	00	00.00	80	66.67
c	Ratio of polybag mixture (3 part soil: 1part FYM: 1 part sand)	05	8.33	15	25.00	40	66.67	00	00.00	23	38.32	37	61.68	05	04.17	36	30.00	79	65.83
Planting in main field																			
a	Age of seedling for transplanting in main field (12-18 months/at 5 leaves stage)	47	72.34	13	21.66	00	00.00	32	53.34	28	46.66	00	00.00	79	65.83	41	34.17	00	00.00
Spacing and direction of planting in main field																			
a	Spacing (2.7m X2.7 m)	43	71.66	17	28.34	00	00.00	37	61.68	23	38.32	00	00.00	80	66.67	40	33.33	00	00.00
b	Pit size (75X75X75cm/90X90X90 cm)	42	70.00	18	30.00	00	00.00	32	53.34	28	46.66	00	00.00	74	61.67	46	38.33	00	00.00
c	Pit filling (Top soil to bottom+15-20 Kg FYM+ bottom soil on top)	49	81.66	11	18.34	00	00.00	32	53.34	28	46.66	00	00.00	81	67.50	39	32.50	00	00.00
d	Direction of planting (North-south&35^0 towards south-west)	28	46.66	00	00.00	32	53.34	10	16.68	00	00.00	50	83.32	38	31.67	00	00.00	82	68.33
Manures and fertilizers																			
a	FYM (20Kg/palm/year)	22	36.66	38	63.34	00	00.00	18	30.00	42	70.00	00	00.00	40	33.33	80	66.67	00	00.00
b	Green manures and quantity (Sunhemp/Dahincha/Cowpea, 20Kg/acre)	37	61.68	23	38.32	00	00.00	27	45.00	21	35.00	12	20.00	64	53.33	44	36.67	12	10
c	Chemical fertilizer (100g N, 40g P, 140g K)	27	45.00	30	50.00	03	05.00	18	30.00	37	61.67	05	08.33	45	37.50	67	55.83	08	6.67

d	Method and placing of fertilizer pre and post monsoon at 1.5-3 feet apart from trunk (band application)	36	60.00	21	35.00	03	05.00	21	35.00	34	56.67	05	08.33	57	47.50	55	45.83	08	6.67
Water management																			
a	Method of irrigation (drip irrigation)	53	88.33	00	00.00	07	11.67	46	76.63	00	00.00	14	23.34	99	82.50	00	00.00	21	17.50
b	Interval of irrigation	47	78.34	13	21.66	00	00.00	38	63.34	22	36.66	00	00.00	85	70.83	35	29.19	00	00.00
Intercropping																			
a	Arecanut + Banana	54	90.00	00	00.00	06	10.00	44	73.33	00	00.00	16	26.67	98	81.67	00	00.00	22	18.33
b	Arecanut + Pepper	12	20.00	00	00.00	48	80.00	03	05.00	00	00.00	57	95.00	15	12.50	00	00.00	105	87.50
Pest, disease and disorder																			
a	Mites management (Dicofol 2.5ml/lit or Dimethoate 1.5ml/lit)	27	45.00	24	40.00	09	15.00	12	20.00	30	50.00	18	30.00	39	32.40	54	45.00	27	22.50
b	Spindle bug management (Quinolphos 2ml/lit or Monocrotophos 1.5ml/lit)	18	30.00	24	40.00	18	30.00	09	15.00	21	35.00	30	50.00	27	22.50	45	37.50	48	40.00
c	Fruit rot/ Koleroga (1 % Bordeaux or 3g COC or 2g Metalaxyl + Mancozeb/lit of water before rainy season)	00	00.00	15	25.00	45	75.00	00	00.00	10	16.68	50	83.32	00	00.00	25	20.83	95	79.17
d	Foot rot/ Anaberoga management Cultural practice + Drenching of propiconazole (1mi/lit) at 15-20 lit/palm / Neem cake application of 2Kg/palm/year.	08	13.33	16	26.68	36	60.00	00	00.00	00	00.00	60	100.00	08	6.67	16	13.33	96	80.00
e	Nut splitting / Andoduku (Borax spray @ 2g/lit or 20g of boron/palm as soil application)	43	71.66	17	28.34	00	00.00	28	46.66	18	30.00	14	23.34	71	59.17	38	31.67	11	9.16
f	Nut dropping (Proper drainage and RDF.)	28	46.66	20	33.34	12	20.00	21	35.00	29	48.34	10	16.68	49	40.83	49	40.83	22	18.34
Harvesting and processing																			
a	Ideal month for harvesting (July-Dec)	51	85.00	09	15.00	00	00.00	43	71.66	17	28.34	00	00.00	94	78.33	26	21.67	00	00.00
b	Ideal stage of nuts for harvesting (6-7 months)	53	88.33	07	11.67	00	00.00	47	78.34	13	21.66	00	00.00	100	83.33	20	16.67	00	00.00
c	Ideal yield of dry nuts (800-1000Kg/acre)	43	71.66	17	28.34	00	00.00	36	60.00	24	40.00	00	00.00	79	65.83	41	34.17	00	00.00

f - Frequency, % - per cent

Table 6. Test of significance to measure difference between production performance of members and non-member arecanut growers of TUMCOS

Si. No	Particulars	N	Mean Rank	Z Score	Sig.
1	Members	60	73.19	-4.001	.000
2	Non-members	60	47.81		

Varieties: In regard with overall arecanut growers, majority (95.83 %) of them had no adoption and 04.17 full adoptions in regard to varieties. The vast majority of the arecanut growers not adopted recommended varieties. This could be attributed due to lack of awareness, information and timely availability of improved arecanut varieties to the arecanut growers.

Nursery management: Among overall arecanut growers, 66.67 % of them had no adoption, 22.50 per cent of them had partial adoption and 10.83 per cent had full adoption in regard to age of mother plant for selection of nuts. 66.67 per cent had not adopted the appropriate dimension polybag required for raising the seedling. More than three-fifth (65.83 %) had not adopted the proper ratio of polybag mixture. Majority of arecanut growers had not adopted the nursery management practices, because of time and experience constraint, they purchase required age seedling from established nursery and transplant then on to main field.

Planting in main field: Among overall arecanut growers, 65.83 per cent had fully adopted the appropriate age of seedling for transplanting in main field. The probable reasons may be that, good quality and appropriate age of seedling for transplanting to main field is the one time strategic investment, which decides the longevity of the plantation; as a result majority of the farmers are adopted appropriate planting in main field.

Spacing and direction of planting in main field: Among overall arecanut growers, 66.67 per cent had fully adopted the recommended spacing. 61.67 per cent had completely adopted and 38.33 per cent had partially adopted the recommended pit size for planting. More than three-fifth (67.50 %) had completely adopted the recommended pit filling practice. 68.33 per cent had not adopted and 31.67 per cent had completely adopted the direction of planting. Majority of arecanut growers have fully adopted the recommended spacing, pit size and method of pit filling. However, more than half of the growers did not adopted direction of planting, which could be attributed to a lack of awareness among the growers about significance of direction of planting in preventing arecanut stem splitting due to direct sunlight.

Manures and fertilizers: Among overall arecanut growers, 66.67 per cent had partially adopted and 33.33 per cent had fully adopted the recommended quantity of FYM. 53.33 per cent and 36.67 per cent had fully, partially adopted and 10.00 per cent had not adopted the recommended quantity of green manures respectively. 55.83 per cent, 37.50 per cent and 6.67 per cent had partially, fully and not adopted recommended chemical fertilizers. 47.50 per cent, 45.83 per cent and 6.67 per cent of growers had adopted completely, partially and did not adopted recommended method of placing the fertilizers. Majority of the growers partially adopted the recommended FYM, green manures and recommended dose of fertilizes due to lack of sufficient knowledge about recommended quantities, as well as lack of availability and high cost of inputs. Results are supported by study conducted by Abhilash, (2017).

Water management: Among overall arecanut growers, 82.50 per cent had fully adopted the recommended method of irrigation. 70.83 per cent and 29.17 per cent had fully and partially adopted recommended interval of irrigation. Majority of growers adopted prescribed irrigation method and appropriate interval of irrigation because to ensure judicious use of scare water resources according to crop requirement, during critical crop periods.

Intercropping: Among overall arecanut growers, 81.67 per cent had completely adopted the arecanut and banana intercropping method. 87.50 per cent had not adopted the arecanut and pepper intercropping method. Majority of the growers adopted arecanut-banana intercropping method. Probable reasons could be, to obtain subsistence income at initial lean period after planting as well as banana crop act as nurse crop for the growth of areca seedling by acting as wind break to areca seedling and shading from

direct sunlight. The fact that vast majority of growers in this region have not adopted arecanut-pepper based intercropping may be due to scarcity of water in summer season, lack of awareness about management practices for intercrop, disease of intercrop may affect the main crop, competition for nutrients between the crops and intercrop may affect the yield of main crop.

Pest, disease and disorder management: Among overall arecanut growers, less than half (45.00 %), 32.50 per cent and 22.50 per cent had partially, completely and not adopted recommended mite management practice. 40.00, 37.50 and 22.50 per cent had not adopted, partially and fully adopted the spindle bug management practice. 79.17 per cent and 20.83 per cent not adopted and partially adopted fruit rot management practice. 80.00 per cent, 13.33 per cent and 6.67 per cent not adopted, partially and fully adopted the foot rot disease management. 59.17 per cent, 31.67 per cent and 9.16 per cent fully adopted, partially and not adopted the nut splitting disorder management. Equally 40.83 per cent had fully and partially adopted and 18.34 per cent had not adopted the recommended nut dropping management practice. Majority of growers partially adopted recommended pest management practices because of lack of availability of skilled labour and difficulty in carrying out of pest management practices. Due to the low prevalence of disease in this location, the majority of arecanut planters had partially adopted the fruit rot and foot rot management practices. More than half of arecanut growers completely adopted management practices of important disorders such as nut dropping and nut splitting, which have a significant impact on the crop's final output and quality (Prakash, 2012).

Harvesting and processing: Among overall arecanut grower, 78.33 per cent had not adopted and 21.67 per cent partially adopted ideal month for harvesting. 88.33 per cent had fully adopted and 16.67 per cent had partially adopted ideal stage of harvesting the nuts for processing. 65.83 per cent and 34.17 per cent had realized optimum and partial ideal yield. Due to their farming experience in raising arecanut crop, most of the farmers followed proper harvesting time and appropriate nut stage for processing which will influence the final yield of dry nuts. Results are supported by the study conducted by Nayak, (2014).

3.1.6 Test of significance to measure difference between production performance of members and non-member arecanut growers of TUMCOS

A close examination of Table 6 presents the results of a Mann-Whitney U test, assessing differences in societal attitudes towards adopting water-efficient practices between the Cauvery and Bhadra command areas across different reaches.

In the case of TUMCOS membership, a Z-score of -4.001 ($p = 0.000$) indicates a highly significant difference in production performance between members and non-members. The low p-value (<0.05) confirms that this difference is not due to random variation but rather reflects a meaningful impact of TUMCOS membership.

This result suggests that TUMCOS members consistently achieve higher production performance than non-members, likely due to several advantages. These include better access to quality agricultural inputs, timely technical guidance, and financial support through the cooperative. Additionally, members may benefit from training programs, extension services, and exposure to improved cultivation practices, all of which contribute to higher productivity and better farm management.

The findings highlight the critical role of cooperative organizations in improving the agricultural performance of farmers. Encouraging greater participation in TUMCOS and extending its benefits to a wider group of growers could help bridge the gap in production performance. Furthermore, targeted interventions for non-members, such as knowledge dissemination, input subsidies, and financial assistance, could enhance their productivity and overall agricultural sustainability.

4. CONCLUSION

The study highlights the significant impact of cooperative membership (TUMCOS) on enhancing the production performance of arecanut growers in Davanagere, Karnataka. Members of TUMCOS benefit from better access to agricultural inputs, training programs, and extension services, leading to improved knowledge, higher adoption of recommended practices, and better production outcomes compared to non-members. Despite these

advantages, a considerable proportion of both members and non-members exhibit medium to low production performance, emphasizing the need for further improvements in farming techniques, technological adoption, and resource utilization. Key challenges include limited awareness of improved arecanut varieties, inadequate adoption of modern pest and disease management strategies, and restricted access to quality inputs. Non-members, in particular, face difficulties due to limited extension support, lack of scientific knowledge, and financial constraints. Strengthening cooperative engagement can significantly enhance productivity by providing training, financial support, and access to essential resources. Implementing capacity-building programs, such as educational initiatives, field demonstrations, and interactive training, can bridge the knowledge gap and promote the adoption of modern cultivation techniques. Encouraging the use of advanced irrigation methods, mechanization, and improved processing units can further enhance efficiency and product quality. Additionally, policy support, including subsidies on fertilizers, improved planting materials, and low-interest loans, can help mitigate financial challenges faced by growers. Expanding extension and advisory services to non-members will facilitate the broader dissemination of best practices, leading to overall improvement in production performance. By addressing these challenges, policymakers, agricultural cooperatives, and extension agencies can work together to improve the livelihoods of arecanut growers, ensuring long-term sustainability and profitability in the sector.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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