ARBUSCULAR MYCORRHIZA FUNGI: THE HIDDEN KEY TO SUSTAINABLE AGRICULTURE

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ABSTRACT

This study investigates farmers' perceptions and adoption rates of AM fungi, identifying obstacles and proposing strategies for widespread implementation. It explores the long-term sustainability and resilience of agricultural systems enhanced by AM fungi, considering their adaptability to evolving climate conditions. Sustainable agriculture is an imperative global goal, given the increasing pressures on food production, environmental conservation and resource preservation. In this context, Arbuscular Mycorrhiza (AM) fungi, often overlooked beneath the soil's surface, emerge as a hidden key to achieving sustainability in agriculture. These symbiotic fungi form mutualistic relationships with the roots of most land plants, offering a multitude of benefits that encompass enhanced nutrient uptake, improved soil structure and heightened resistance to abiotic and biotic stressors. It aims to assess their diversity, quantify their impact on crop growth and evaluate their contributions to nutrient cycling and soil health.

Keywords: Arbuscular Mycorrhiza, sustainability, mutualistic relationships, nutrient, soil health and crop growth.

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1. INTRODUCTION

The key to a resilient and environmentally responsible future lies not only in what can be seen above the soil but also in the hidden realms beneath. The urgency to feed a growing global population while preserving our planet's delicate ecosystems has propelled scientists and agriculturists to explore novel avenues of innovation. One such avenue, often overlooked but with tremendous potential, involves the intricate relationships between plants and Arbuscular Mycorrhiza (AM) fungi. The Earth's soil, teeming with life, has long been recognized as a cradle of agricultural prosperity. It provides the foundation upon which civilizations have thrived, offering the essential nutrients and stability required for robust crop growth. However, conventional agricultural practices, marked by intensive chemical inputs, monocultures and soil degradation, have strained this vital resource and challenged its ability to meet the demands of a burgeoning global population.

In this era of climate change and environmental awareness, the call for sustainable agriculture has never been more resounding. Sustainability demands a holistic approach—one that not only increases yields but also nurtures the soil, conserves water and reduces the environmental footprint of farming. It necessitates a paradigm shift, a reimagining of agriculture that harnesses the potential of the symbiotic relationship between plants and AM fungi, a relationship that has evolved over hundreds of millions of years.

Arbuscular Mycorrhiza Fungi, residing beneath the soil's surface, are integral components of this ancient alliance. These microscopic organisms form intricate networks of hyphal threads within plant roots, extending their reach far beyond what plants can achieve alone. In return for carbohydrates provided by the plant, AM fungi offer a multitude of benefits, including enhanced nutrient uptake, improved soil structure and heightened resistance to abiotic and biotic stressors. Their role in enhancing plant health and soil quality has long been recognized by scientists, yet their full potential in sustainable agriculture has often been underestimated or overshadowed by more conventional farming practices. Through a comprehensive exploration of their diversity, their impact on crop growth, their contributions to nutrient cycling and their influence on soil health. We will undertake a comparative analysis, pitting conventional farming practices against those embracing AM fungi-based biostimulants, to reveal their potential economic, environmental and social advantages. The long-term sustainability and resilience of agricultural systems enhanced by AM fungi, with an eye towards their adaptability to evolving climate conditions.

2. REVIEW OF LITERATURE

Agueegue M. R, Noumavo, A.P, Dagbenonbakin G, Agbodjato A. N, Assogba S, Koda A.D, *et al*. (2017) examined that Corn (Zea mays) is one of the world's most widely cultivated crops, playing a crucial role in global food security, animal feed production and various industrial applications. Its success as a staple crop relies heavily on the application of fertilizers to enhance nutrient availability and ensure optimal growth. However, traditional fertilization practices often come with environmental and economic challenges, including nutrient runoff, greenhouse gas emissions and rising fertilizer costs. As agriculture seeks sustainable and eco-friendly alternatives, Arbuscular Mycorrhizal (AM) fungi emerge as a promising option for improving corn cultivation.

Aroca R., Porcel R, and Ruiz-lozano J. M. (2007), stated that Arbuscular Mycorrhizal symbiosis, a widespread and ecologically significant mutualistic association between plant roots and soil fungi, plays a pivotal role in enhancing plant performance and nutrient acquisition. While much research has focused on the Mycorrhizal influence on nutrient uptake and plant growth, a critical yet often overlooked aspect of this symbiosis is its impact on root hydraulic properties. Root hydraulic properties determine a plant's ability to transport water from the soil to the aboveground parts, regulating its overall water status and resilience to various environmental stresses, including drought.

Assogba A. S, Ahoyo Adjovi N, Agbodjato A. N, Sina H, Adjanohoun A and Baba-moussa L (2020), found that AMF represent a diverse group of soil microorganisms that form symbiotic associations with the roots of most terrestrial plants. These fungi play a crucial role in enhancing plant nutrient uptake, improving soil structure and conferring various other benefits to their host plants. While the use of commercial AMF strains has gained attention in agriculture, there is growing interest in evaluating the mixed effects of indigenous strains of AMF. Indigenous AMF strains are naturally occurring in specific ecosystems and may offer unique advantages in terms of adaptability and ecosystem compatibility. This study aims to evaluate the mixed effects of some indigenous strains of AMF on plant growth, nutrient uptake and soil health.

Germida J. Hamel C, Atul-Nayyar A and Hanson K (2009) it explores the intricate mechanisms through which AM symbiosis facilitates N acquisition by plants, highlighting the role of these fungi in mediating N cycling in terrestrial ecosystems. The

Arbuscular mycorrhizal symbiosis is a fundamental mutualistic association between soil-dwelling fungi and most terrestrial plants. This symbiosis plays a pivotal role in nutrient acquisition, particularly in the uptake of nitrogen (N), an essential nutrient for plant growth and development. Nitrogen exists in various forms in soil, including organic N compounds and inorganic N (e.g., ammonium and nitrate). The efficient utilization of these N sources is crucial for plant health and ecosystem productivity. AM fungi, by colonizing plant roots, can influence the availability of N forms in the rhizosphere, linking N mineralization to plant demand.

Balestrini R., Berruti A., Bianciotto and V. Lumini E (2016) ascertained that the role of AMF as natural biofertilizers, focusing on their mechanisms of action, benefits, and practical applications in sustainable agriculture. Agriculture faces the dual challenge of increasing crop yields to meet growing global food demands while reducing the environmental impact of conventional farming practices. In this context, Arbuscular Mycorrhizal Fungi (AMF) emerge as natural biofertilizers with the potential to enhance crop productivity, improve soil health and reduce the reliance on synthetic fertilizers. AMF establish symbiotic relationships with the majority of terrestrial plants, facilitating nutrient uptake and promoting plant growth.

Bethlenfalvay G., and Linderman R. (1992) examined that sustainable agriculture is an imperative response to the global challenges of food security, environmental degradation and resource conservation. At its core, sustainable agriculture seeks to balance the need for increased crop production with the preservation of ecosystems, soil health and biodiversity. In this endeavor, mycorrhizal fungi, which form mutualistic symbiotic associations with the roots of most terrestrial plants, emerge as valuable allies. Mycorrhizae play a pivotal role in sustainable agriculture by promoting nutrient uptake, enhancing soil structure, increasing crop resilience and reducing the reliance on synthetic inputs.

Khan A., Ding Z. T., Ishaq M., Khan I., Ahmed A. A., Khan A. Q., *et al*. (2020), this review aims to underscore the significance of PGPR and mycorrhizae in shaping a more sustainable and resilient future for agriculture and ecosystem management. The mechanisms underlying their beneficial effects, their potential synergistic interactions and their practical applications in sustainable agriculture and ecosystem restoration. In the pursuit of sustainable and environmentally responsible agricultural practices, harnessing the potential of beneficial Plant Growth-Promoting Rhizobacteria (PGPR) and Mycorrhizal fungi has gained prominence. These microorganisms form symbiotic relationships with plants, facilitating nutrient acquisition, disease suppression and stress tolerance, thereby promoting plant growth and health. By elucidating the complex and dynamic interplay between these microbial partners and their host plants.

Koda A. D., Dagbénonbakin, G., Assogba F., Agbodjato N. A., N'Tcha C., Assogba S., *et al*. (2020), this study provide insights into their potential as a sustainable and regenerative solution for modern agriculture, addressing the challenges of food security and environmental stewardship in an ever-changing world. By evaluating the ecological and agronomic implications of native AMF-based fertilizers. Arbuscular Mycorrhizal Fungi play a pivotal role in enhancing nutrient uptake and promoting plant growth in terrestrial ecosystems. As an eco-friendly alternative to conventional fertilizers, native AMF-based fertilizers have garnered attention for their potential to improve crop productivity while reducing the environmental impact of agriculture.

Wu Q., Li, G., and Zou Y. (2011) they stated that the multifaceted effects of AMF on plant growth and nutrient uptake, shedding light on the intricate mechanisms underlying this mutualistic relationship. Arbuscular Mycorrhizal Fungi form ubiquitous symbiotic associations with the roots of most terrestrial plants, influencing plant growth and nutrient acquisition. Understanding the intricate interplay between AMF, plants and the environment is crucial for harnessing the potential of these fungi to address the complex challenges facing agriculture and environmental conservation in the 21st century.

Smith S.E. and Read D. (2008) it explores the intricacies of symbionts forming Arbuscular Mycorrhizas, focusing on the key players, mechanisms and ecological consequences of this remarkable biological partnership. Mycorrhizal symbiosis, particularly the Arbuscular Mycorrhizal (AM) association, represents one of the most widespread and ecologically significant mutualistic interactions in terrestrial ecosystems. By illuminating the complexities and ecological significance of symbionts forming Arbuscular Mycorrhizas, this review contributes to our understanding of these fundamental interactions and their implications for the sustainable management of terrestrial ecosystems and agriculture.

Duc N.H.; Csintalan Z.; Posta K. (2018) they revealed that the mechanisms through which AMF enhance plant stress tolerance, including improved nutrient uptake, enhanced antioxidant defenses and hormonal regulation. Arbuscular Mycorrhizal

Fungi have garnered attention for their remarkable ability to mitigate negative effects on plants arising from a wide range of environmental stressors. Understanding how AMF can alleviate negative effects on plants offers a promising avenue for addressing the complex challenges posed by global environmental changes and their impacts on plant health and ecosystem resilience.

3. ARBASCULAR MYCORRHIZA FUNGI

Arbuscular Mycorrhiza (AM) fungi play a pivotal role in sustainable agriculture, contributing to various factors that promote both environmental and economic sustainability. Here are some key factors where AM fungi are the hidden key to sustainable agriculture:

i. Enhanced Nutrient Uptake

AM fungi form extensive networks of hyphal threads that effectively increase the surface area for nutrient absorption by plant roots. This results in improved uptake of essential nutrients, particularly phosphorus and various micronutrients, reducing the need for synthetic fertilizers and making agriculture more resource-efficient.

ii. Improved Soil Structure

The action of AM fungi in binding soil particles together with their hyphal networks enhances soil aggregation and stability. This improves soil structure, reducing erosion, enhancing water infiltration and increasing soil water-holding capacity, all of which contribute to long-term soil health and resilience.

iii. Disease Resistance

AM fungi can confer resistance to various soil-borne pathogens. They establish a protective barrier around plant roots, making it more challenging for harmful organisms to access and infect the roots.

iv. Drought Tolerance

AM fungi can enhance a plant's ability to withstand drought conditions. They improve water retention in the soil and facilitate the absorption of water by plant roots, helping crops endure periods of water scarcity or drought stress.

v. Reduced Chemical Inputs

The symbiotic relationship between plants and AM fungi can lead to reduced dependency on synthetic fertilizers and pesticides. This not only lowers production costs for farmers but also reduces the environmental impact associated with chemical inputs.

vi. Carbon Sequestration

Mycorrhizal networks contribute to carbon sequestration in soils. As plants transfer carbohydrates to AM fungi, a portion of that carbon is stored in the soil as organic matter, aiding in climate change mitigation.

vii. Biodiversity Conservation

AM fungi can have positive effects on plant diversity and ecosystem stability. They often associate with a wide range of plant species, facilitating the establishment and growth of various plants in natural and agricultural ecosystems.

viii. Increased Crop Yields

Studies have shown that AM fungi can significantly increase crop yields, especially in nutrient-poor soils. This boost in productivity can help meet the demands of a growing global population while using fewer external inputs.

ix. Long-term Soil Fertility

AM fungi contribute to the long-term fertility of agricultural soils by improving nutrient cycling and reducing nutrient leaching. This reduces the need for frequent soil amendments and helps maintain soil health over time.

x. Sustainability in Marginal Lands

AM fungi can be particularly beneficial in marginal or degraded lands, where conventional agriculture may not be feasible. They can help rehabilitate and restore such areas, increasing their agricultural potential and overall sustainability.

xi. Resilience to Climate Change

AM fungi can enhance plant resilience to changing climate conditions, such as increased temperatures and altered precipitation patterns. This adaptability can contribute to the sustainability of agriculture in the face of climate-related challenges.

3.1. Understanding AM Fungi

Understanding the biology and ecological significance of AM fungi is crucial for optimizing agricultural practices, conserving biodiversity and mitigating the effects of climate change. Harnessing the hidden potential of these fungi can lead to more sustainable and resilient ecosystems and contribute to the global effort to address pressing environmental and food security challenges.

3.2. Adoption and Barriers

Arbuscular mycorrhizal fungi (AMF) have emerged as a promising tool for sustainable agriculture, offering numerous benefits, including improved nutrient uptake, enhanced crop yield and reduced environmental impact. However, the adoption of AMF-based practices in agriculture faces a complex interplay of factors that can either promote or hinder its integration into mainstream farming.

Efforts to facilitate AMF adoption must encompass educational outreach, research addressing variability, development of cost-effective inoculants and supportive policy frameworks. Emphasizing the long-term benefits, including enhanced soil health and resilience, can help surmount initial barriers and pave the way for the widespread integration of AMF into sustainable agriculture practices.

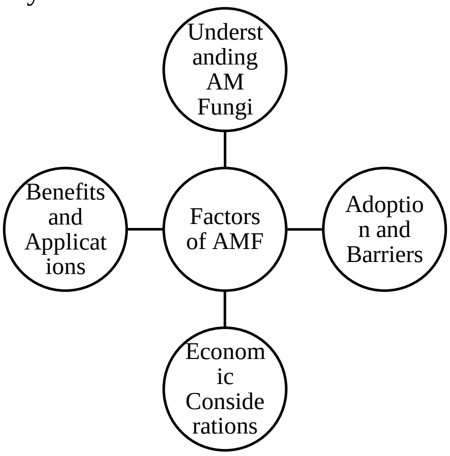
3.3 Economic Considerations

Arbuscular mycorrhizal fungi have garnered increasing attention for their potential economic impact on agriculture. These microscopic symbiotic organisms form mutually beneficial associations with plant roots, offering a range of advantages that can translate into economic benefits for farmers and the broader agricultural sector.

3.4 Benefits and Applications

Arbuscular mycorrhizal fungi play a pivotal role in enhancing plant health and ecosystem sustainability. Their mutualistic associations with the majority of terrestrial plants offer a plethora of benefits that extend beyond agriculture and encompass various ecological applications. Understanding the diverse benefits and applications of AMF is essential for harnessing their potential in agriculture, environmental management and ecological restoration.

4. RESEARCH MODEL



5. OBJECTIVES OF THE STUDY

1. To calculate the economic implications of adopting AM fungi-based Biostimulants in agriculture, considering factors like production costs, yields and market value.
2. To investigate the impact of AM fungi on plant growth, including factors like increased nutrient uptake and improved water retention.

6. HYPOTHESIS OF THE STUDY

a. There is an association between age and Economic Considerations.

b. There is an association between age and Understanding AM Fungi

7. RESEARCH METHODOLOGY

The study of Arbuscular Mycorrhiza fungi and their role in sustainable agriculture typically involves a combination of field work as well as data analysis. Start by conducting a comprehensive literature review to understand the current state of knowledge regarding Arbuscular Mycorrhiza fungi and their impact on sustainable agriculture. 150 questionnaires was used to collect data, received 130 questionnaires and usable is 117. Hence, the sample size of this study is 117. The Cronbach‘s Alpha Value of this study is 0.907 which is more than 0.7. Therefore, the reliability of the questionnaire is proved.

8. ANALYSIS AND RESULTS

8.1. KMO and Bartlett's Test

Table: 1

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.813
Bartlett's Test of Sphericity	Approx. Chi-Square	1096.891
	df	153
	Sig.	.000

KMO is an index which defines the sampling adequacy. The KMO value of this study is 0.813 which is more than 0.5. Therefore, it is considered as Excellent.

8.2 COMMONALITY TABLE

Table: 2

Communalities		
	Initial	Extraction
AM fungi contribute to improving soil health and structure.	1.000	.532
AM fungi can enhance nutrient uptake by plants.	1.000	.649
It protect plants from soil-borne diseases and pests.	1.000	.611
The adoption of AM fungi-based practices in agriculture is currently widespread.	1.000	.665
Farmers face significant challenges when trying to adopt AM fungi-based agricultural practices.	1.000	.716
Lack of awareness about AM fungi is a significant barrier to their adoption in agriculture.	1.000	.693
The perceived cost of implementing AM fungi-based practices is a barrier for farmers.	1.000	.661
Government policies and incentives can play a crucial role in promoting the adoption of AM fungi-based practices in agriculture.	1.000	.674
There is a lack of access to AM fungi-based products or services for farmers.	1.000	.726
The use of AM fungi in agriculture is cost-effective for farmers.	1.000	.366
Investment in AM fungi-based practices can lead to higher long-term returns for farmers.	1.000	.724
Government subsidies or incentives for AM fungi adoption would be beneficial for farmers.	1.000	.590
The reduction in the need for synthetic fertilizers and pesticides through AM fungi use can result in significant cost savings for farmers.	1.000	.538
The initial costs associated with implementing AM fungi-based practices are a significant barrier for farmers.	1.000	.744
It can contribute to reducing the need for synthetic fertilizers and pesticides in agriculture.	1.000	.822
AM fungi can be in promoting the long-term sustainability of agricultural systems.	1.000	.744
AM fungi can effectively improve soil structure and health in agricultural ecosystems.	1.000	.559
The use of AM fungi has the potential to increase crop yields while maintaining sustainability.	1.000	.467
Extraction Method: Principal Component Analysis.		

Source: Primary Data

Initially, the variables of Arbascular Mycorrhiza Fungi in the communality table is expected to share 100% variance. Therefore, the initial value of each items is 1.00 which means 100% variance share by each item. The extraction value is ranging from 0.366 to 0.822 which shows that minimum variance share of item after extraction is 36.60% and maximum variance share of item is 82.20%.

8.3 TOTAL VARIANCE EXPLAINED

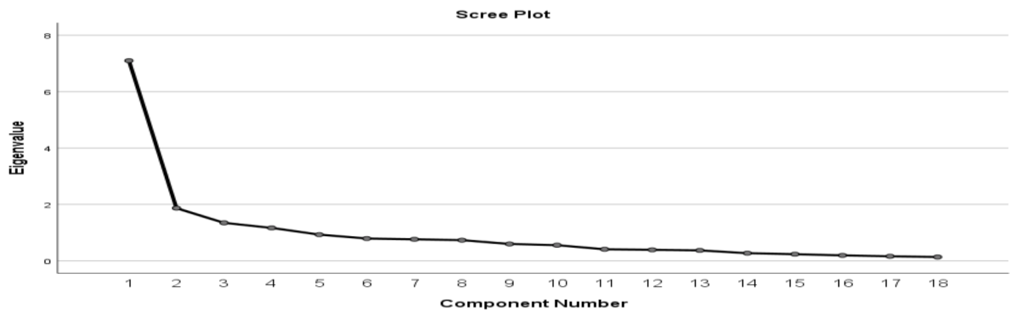
Table: 3

Total Variance Explained									
	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	7.099	39.439	39.439	7.099	39.439	39.439	3.211	17.841	17.841
2	1.867	10.373	49.812	1.867	10.373	49.812	3.126	17.364	35.205
3	1.346	7.476	57.288	1.346	7.476	57.288	2.691	14.952	50.157
4	1.166	6.480	63.768	1.166	6.480	63.768	2.450	13.612	63.768
5	0.928	5.157	68.926	NA	NA	NA	NA	NA	NA
6	0.790	4.390	73.316	NA	NA	NA	NA	NA	NA
7	0.762	4.233	77.549	NA	NA	NA	NA	NA	NA
8	0.733	4.070	81.619	NA	NA	NA	NA	NA	NA
9	0.597	3.317	84.936	NA	NA	NA	NA	NA	NA
10	0.553	3.073	88.009	NA	NA	NA	NA	NA	NA

11	0.409	2.271	90.280	NA	NA	NA	NA	NA	NA
12	0.389	2.163	92.443	NA	NA	NA	NA	NA	NA
13	0.369	2.051	94.495	NA	NA	NA	NA	NA	NA
14	0.270	1.499	95.994	NA	NA	NA	NA	NA	NA
15	0.234	1.302	97.296	NA	NA	NA	NA	NA	NA
16	0.192	1.068	98.363	NA	NA	NA	NA	NA	NA
17	0.160	0.890	99.253	NA	NA	NA	NA	NA	NA
18	0.135	0.747	100.000	NA	NA	NA	NA	NA	NA
Extraction Method: Principal Component Analysis.									

The evident from the above table that the 18 constructs, comprising of 4 items that are extracted cumulatively explains 63.768% of the total variance.

Chart 1: Scree Plot



8.4 Rotated Component Matrix

Table: 4

Rotated Component Matrix[a]				
	Component			
	1	2	3	4
It can contribute to reducing the need for synthetic fertilizers and pesticides in agriculture.	.890			
AM fungi can be in promoting the long-term sustainability of agricultural systems.	.797			
AM fungi can effectively improve soil structure and health in agricultural ecosystems.	.626			
AM fungi contribute to improving soil health and structure.	.582			
The initial costs associated with implementing AM fungi-based practices are a significant barrier for farmers.	.567	.428		
The use of AM fungi in agriculture is cost-effective for farmers.				
Government policies and incentives can play a crucial role in promoting the adoption of AM fungi-based practices in agriculture.		.755		
The perceived cost of implementing AM fungi-based practices is a barrier for farmers		.739		
Lack of awareness about AM fungi is a significant barrier to their adoption in agriculture.		.661		
There is a lack of access to AM fungi-based products or services for farmers.		.599		.454
The use of AM fungi has the potential to increase crop yields while maintaining sustainability.	.427	.516		
The reduction in the need for synthetic fertilizers and pesticides through AM fungi use can result in significant cost savings for farmers.		.511		.427
The adoption of AM fungi-based practices in agriculture is currently widespread.			.795	
Farmers face significant challenges when trying to adopt AM fungi-based agricultural practices.			.766	
It protect plants from soil-borne diseases and pests.			.725	
Investment in AM fungi-based practices can lead to higher long-term returns for farmers.				.793
Government subsidies or incentives for AM fungi adoption would be beneficial for farmers.				.640

AM fungi can enhance nutrient uptake by plants.			.436	.548
Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.				
a. Rotation converged in 7 iterations.				

The above table indicated that the fixing of cut-off point through rotation component matrix. In this way there are 5 variables under component 1, 6 variables under component 2, 3 variables under component 3 and 3 variables under component 2. The factors taken for this study is Understanding AM Fungi, Adoption and Barriers, customization, Economic Considerations and Benefits and Applications.

8.5 ANOVA

Table: 5

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
Understanding AM Fungi	Between Groups	39.027	3	13.009	11.752	.000
	Within Groups	125.092	113	1.107		
	Total	164.120	116			
Adoption and Barriers	Between Groups	5.889	3	1.963	1.519	.213
	Within Groups	146.026	113	1.292		
	Total	151.915	116			
Economic Considerations	Between Groups	.693	3	.231	.179	.910
	Within Groups	145.837	113	1.291		
	Total	146.530	116			
Benefits and Applications	Between Groups	35.309	3	11.770	9.645	.000
	Within Groups	137.888	113	1.220		
	Total	173.197	116			

Source: Primary Data

It was found from the above table, the p-value of Understanding AM Fungi and Benefits and Applications is less than 0.05 at 5% level of significance. Therefore, null hypothesis is rejected, it was ascertained from this study there is a significant relationship between Understanding AM Fungi, Benefits and Applications and age of the respondents. The p-value of Adoption and Barriers and Economic Considerations is more than 0.05 at 5% level of significance. Hence, null hypothesis is accepted. It was found from this study, there is no relationship between Adoption and Barriers, Economic Considerations and age of the respondents.

8.6 POST HOC TUKEY HSD TEST

Table: 6

Multiple Comparisons							
Tukey HSD							
						95% Confidence Interval	
Dependent Variable	(I) Age	(J) Age	Mean Difference (I-J)	Std. Error	Sig.	Lower Bound	Upper Bound
Understanding AM Fungi	Below 30	30-40 years	.031	.213	.999	-.52	.59
		41-50 years	-1.294*	.450	.024	-2.47	-.12
		above 50 years	-2.044*	.395	.000	-3.07	-1.01
	30-40 years	Below 30	-.031	.213	.999	-.59	.52
		41-50 years	-1.325*	.461	.024	-2.53	-.12
		above 50 years	-2.075*	.407	.000	-3.14	-1.01
	41-50 years	Below 30	1.294*	.450	.024	.12	2.47

		30-40 years	1.325*	.461	.024	.12	2.53
		above 50 years	-.750	.568	.552	-2.23	.73
	above 50 years	Below 30	2.044*	.395	.000	1.01	3.07
		30-40 years	2.075*	.407	.000	1.01	3.14
		41-50 years	.750	.568	.552	-.73	2.23
Adoption and Barriers	Below 30	30-40 years	-.276	.230	.628	-.88	.32
		41-50 years	.183	.486	.982	-1.08	1.45
		above 50 years	.599	.427	.499	-.51	1.71
	30-40 years	Below 30	.276	.230	.628	-.32	.88
		41-50 years	.458	.498	.794	-.84	1.76
		above 50 years	.875	.440	.199	-.27	2.02
	41-50 years	Below 30	-.183	.486	.982	-1.45	1.08
		30-40 years	-.458	.498	.794	-1.76	.84
		above 50 years	.417	.614	.905	-1.18	2.02
	above 50 years	Below 30	-.599	.427	.499	-1.71	.51
		30-40 years	-.875	.440	.199	-2.02	.27
		41-50 years	-.417	.614	.905	-2.02	1.18
Economic Considerations	Below 30	30-40 years	-.046	.230	.997	-.64	.55
		41-50 years	-.246	.485	.957	-1.51	1.02
		above 50 years	-.246	.426	.939	-1.36	.87
	30-40 years	Below 30	.046	.230	.997	-.55	.64
		41-50 years	-.200	.497	.978	-1.50	1.10
		above 50 years	-.200	.440	.969	-1.35	.95
	41-50 years	Below 30	.246	.485	.957	-1.02	1.51
		30-40 years	.200	.497	.978	-1.10	1.50
		above 50 years	.000	.614	1.000	-1.60	1.60
	above 50 years	Below 30	.246	.426	.939	-.87	1.36
		30-40 years	.200	.440	.969	-.95	1.35
		41-50 years	.000	.614	1.000	-1.60	1.60
Benefits and Applications	Below 30	30-40 years	-.255	.223	.664	-.84	.33
		41-50 years	-.230	.472	.962	-1.46	1.00
		above 50 years	-2.230*	.415	.000	-3.31	-1.15
	30-40 years	Below 30	.255	.223	.664	-.33	.84
		41-50 years	.025	.484	1.000	-1.24	1.29
		above 50 years	-1.975*	.428	.000	-3.09	-.86
	41-50 years	Below 30	.230	.472	.962	-1.00	1.46
		30-40 years	-.025	.484	1.000	-1.29	1.24
		above 50 years	-2.000*	.597	.006	-3.56	-.44
	above 50 years	Below 30	2.230*	.415	.000	1.15	3.31
		30-40 years	1.975*	.428	.000	.86	3.09
		41-50 years	2.000*	.597	.006	.44	3.56

*. The mean difference is significant at the 0.05 level.

Post Hoc- Tukey HSD test is used to test the significant difference between groups based mean difference. It was ascertained from this study above 50 age group respondents have more mean difference as compared with the other age group respondents. It was found from this study, above 50 age group respondents strongly agreed the factors such as understanding AM fungi, economic considerations and benefits and applications is most important for improve the productivity.

The respondents belongs to 31 – 40 years have more mean difference as compared with other age group respondents. This study revealed that 31 – 40 age group respondents strongly agreed that the factor adoption and barriers will helpful to the farmers to increase the productivity.

8.7 CONFIRMATORY FACTOR ANALYSIS (CFA)

Figure: 1

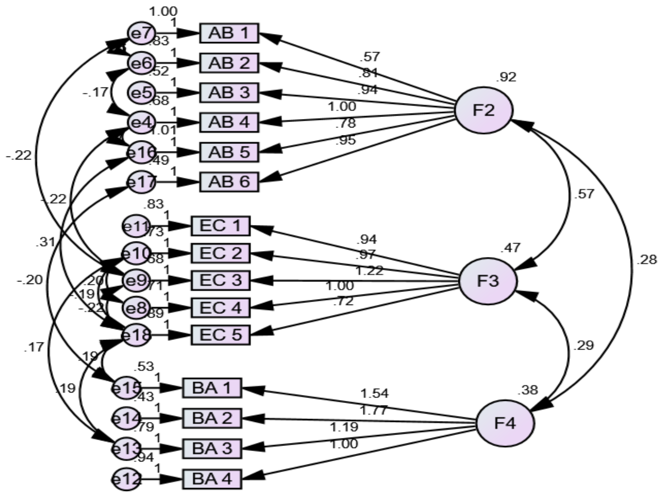


Table: 7

S.NO	Measure	Recommended value	Observed Values	Interpretation
1	CMIN/DF	Between 1 and 3	1.723	Excellent
2	CFI	>0.95	0.931	Excellent
3	AGFI	>0.80	0.807	Excellent
4	IFI	>0.90	0.934	Excellent
5	TLI	>0.90	0.902	Excellent
6	RMSEA	<0.08	0.079	Excellent

The model fitness CMIN/DF= 1.723, the discrepancy divided by degrees of freedom is 127.477 / 74 = 1.723, CFI = 0.931, AGFI= 0.807, IFI = 0.934, TLI= 0.902 and RMSEA= 0.079.

9. FINDINGS

- Some indigenous AMF strains may enhance plant growth parameters, such as height and biomass, compared to non-inoculated controls.
- AMF may increase nutrient uptake by host plants, particularly phosphorus and micronutrients, leading to improved nutrient status in plants.
- Indigenous AMF may positively influence soil health by increasing microbial diversity, nutrient cycling and soil structure.
- AM fungi extend their hyphal networks into the soil, significantly increasing the volume of soil explored for nutrients. This extension enables the fungi to access and deliver N forms, such as ammonium and nitrate, to the host plant, enhancing N uptake efficiency.
- AMF can solubilize insoluble forms of phosphorus, making it more accessible to plants. This is particularly beneficial in phosphorus-deficient soils.
- Mycorrhizal associations improve the plant's water-absorbing capacity, aiding in drought tolerance and overall water-use efficiency.
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10. CONCLUSION

Arbuscular Mycorrhiza Fungi offer a sustainable and ecologically friendly solution to many of the challenges faced by modern agriculture. Their ability to enhance nutrient uptake, improve drought resistance, suppress diseases and promote soil health makes them a valuable asset in the quest for sustainable and resilient food production systems. Further research and the incorporation of AMF into agricultural practices should be encouraged to harness their full potential for the benefit of both farmers and the environment.

The mutualistic relationship is characterized by the fungal hyphae colonizing the root system, creating a vast network that extends the plant's nutrient-absorbing capacity. This symbiosis not only benefits the plant but also has the potential to revolutionize corn cultivation by reducing the reliance on conventional fertilizers. Understanding the intricate relationship between AM symbiosis and root hydraulic properties is crucial for elucidating the mechanisms underlying the improved drought tolerance observed in Mycorrhizal plants. Additionally, this knowledge can have far-reaching implications for sustainable agriculture, where water scarcity is a pressing concern and optimizing water-use efficiency is paramount.

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