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ORDINAL REGRESSION MODELING FOR THE LEVEL OF ABACA PRODUCTION IN EASTERN VISAYAS, PHILIPPINES

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Abstract

This article elucidated the level of abaca production in Eastern Visayas, Philippines, and developed a statistical model that determined its significant governing factors. A cross-sectional survey and primary data collection were done to gather sufficient information through a face-to-face interview with a random sample of 349 abaca farmers. The study used standard statistical metrics to describe the data and presented it in a tabular form. In addition, ordinal regression was employed to model the factors governing the level of abaca production in the Region and tested its significance at standard level. Results portrayed that, on average, the production of the abaca industry in Eastern Visayas is considered at a moderate level. This implies that the abaca production in the region has still room for improvement. It is found that abaca farmers in the region only interact with the traders and have no engagement with other players such as enablers (PhilFIDA, SUCs, and LGU) due to some constraints. The results of the first ordinal regression revealed that the factors affecting the level of abaca production are the age of farmers (ρ_1=0.027, p-value=0.003) and the size of the farm (ρ_6=-0.564, p-value<0.001). This implies that older farmers are more knowledgeable in applying innovative techniques that enhance production activities. Moreover, the smaller size of the abaca farm is easy to manage and apply technologies to improve production levels as opposed to bigger farms. The second ordinal regression showed that farming experience (λ_4=0.015, p-value=0.038) is a significant predictor of abaca production level which indicates that experienced farmers are more productive and competitive.

Key words: *abaca fiber, production level, predictors, regression modeling*

INTRODUCTION

Abaca (*Musa textilis Née*) is one of the important plants grown in the Philippines due to its various uses and economic valuation [22], [26]. Nowadays, the abaca industry in the Philippines is significantly contributing to the abaca market globally and enhancing the gross domestic product (GDP) in the country [24]. Moreover, it is portrayed in [25] that abaca farming in the Philippines has cultural practices, values, and beliefs that change the lives of farmers both economically and socially. In fact, abaca farming is one of the major sources of livelihood for hundreds of Filipinos in many provinces in the country [22]. Abaca is a very useful fiber and a variety of products can be made that can be exported to other countries and a good source of sustainable commodities for economic activities [10], [24]. In [26] and [29], it is depicted that abaca fiber can be used as a renewable bio-resource for commercial enterprise purposes and other products that lead to sustainable and natural manner. Hence, abaca production is one of the important focuses of the Philippine government providing budget support and implementing some policies on how to improve and grow economically.

As time goes by, there are problems existing in abaca production that farmers are having difficulty facing such as climate change, lack of agricultural innovations, lack of capital, poor market roads, lack of extension agents, and pests and diseases, among others [17], [20]. How the study in [3], it is portrayed that the Philippine Fiber Industry Development Authority (PhilFIDA) is responsible for the development and growth of natural fiber in the country through research and innovation. Moreover, in [10] and [11], it is deemed that PhilFIDA has helped the abaca plantation in the country through production support, educating and training farmers, extension support, and treating pests and diseases. In addition, some state universities and colleges (SUCs) in the country are also supporting the abaca farmers through research and extension [19] as well as local government units (LGU) are aiding farmers in regard to their agricultural inputs [5]. In that case, some farmers in the country are being helped with their problems in growing abaca and being provided support in improving the production level. Moreover, the government has supported many scientists who study the structures of abaca that provide solutions to the different existing problems and challenges including pests and diseases, climate change, and the cultivation process, among others [4], [21], [25], [28]. Plus, the government also supported scientists that develop agricultural materials and products from abaca fiber which constitute the Philippine economy [6], [12], [13], [24], [29]. Hence, to enhance the abaca production in the country, it is necessary to investigate the farmers' situation in their farming activities and satisfaction with the help and support they have received.

Although there are existing studies in the literature regarding abaca fiber production in the Philippines, investigating the production level through statistical modeling is scarce. In fact, constructing an ordinal regression model to identify the predictors of abaca production in rural areas in the Philippines has never been done before. Thus, to fill in the research gap, this article study is executed. Generally speaking, this article develops an optimal statistical model that determines the significant factors influencing the abaca production level in Eastern Visayas, Philippines. Specifically, the article dealt with the following goals: (i) to construct a profile of the abaca farmers in Eastern Visayas, Philippines; (ii) to measure the level of abaca production; and (iii) to develop a regression model that determines the predictors of abaca production level. The significance of this paper is to pave an overview of the production of abaca to give possible solutions to some existing problems in farming activities. Results of the study may provide information in enhancing a policy package that improves the production of abaca and farmers' income level as well as their well-being. Moreover, the findings of this paper may recommend some ways to enhance the current production of abaca and progress the exports of various abaca products for the development of the Philippine economy. Furthermore, the article may be used as a benchmark for abaca researchers and agricultural extension agents to improve their strategies in interacting with the farmers and other stakeholders, and the paper may serve as a piece of new novel information to the global literature on agriculture sustainability.

MATERIALS AND METHODS

Research Design

This paper article employed a quantitative survey in gathering the information needed in the type of cross-sectional data. Since the study investigated the degree of influence of independent variables on dependent variables, a complex correlational was utilized as a research design. In summarizing the variables, the article used some standard descriptive metrics and presented them in statistical tables. Regarding the determination of relationships or correlations among variables, a statistical inference was computed in the form of regression modeling. In that case, necessary measures and predictions were drawn with statistical evidence.

Research Locale, Respondents, and Sampling

Eastern Visayas is known to have a wide abaca production and industry in the country [22]. Hence, this study considered all the abaca farmers in Eastern Visayas or Region VIII, Philippines as a population of interest. Official lists of abaca farmers in each municipality were secured in the Office of Agriculture. The sample size used for the survey was computed using Slovin's formula with an appropriate margin of error set by the researchers. After that, the sample size was proportionate in each province in Eastern Visayas, and the province being chosen was based on the level of how abaca cultivation is abundant. Hence, a total of 349 abaca farmers were selected in a random manner. In that case, there are 27 farmers chosen from Southern Leyte within three municipalities, 45 framers from the seven municipalities of Leyte, 46 farmers from the four municipalities of Biliran, 21 farmers from the three municipalities of Eastern Samar, and 210 farmers from the nine municipalities of Northern Samar. Map 1 presents the different provinces of Eastern Visayas and each municipality that was part of the survey study.

Map 1. Region VIII, Eastern Visayas, Philippines.
Source: [14].

Survey Instrument and Data Collection

The study used a developed structured questionnaire where the content was based on the current study in literature [8], [22]. The questionnaire has three (3) parts such as (i) demographic and farming profile, (ii) engagement of abaca farmers to the other players in the industry (PhilFIDA, SUCs, and LGU) known as extension actors, (iii) level of abaca production. As for the demographic and farming profile of abaca farmers, the following were asked: (1) age in years, (2) sex, (3) marital status, (4) number of years in education, (5) other income aside from abaca farming, (6) size of abaca farm in hectare/s, (7) tenurial status, (8) years in farming, (9) distance from abaca farm to house, (10) any agency in abaca farming that visits. As for the second part, the abaca farmers were asked about their level of engagement with the other players (PhilFIDA, SUCs, and LGU) using a 1 to 4 scaling. In that case, 1 indicates no engagement (or interaction) and 4 indicates a strong engagement. Table 1 shows the various range of values that the mean engagement perception scores will possibly fall and its corresponding verbal interpretation.

Table 1. Engagement perception scores.

Perception scores	Description
1.00-1.75	No engagement
1.76-2.50	Weak engagement
2.51-3.25	Moderate engagement
3.26-4.00	Strong engagement

Source: Authors' guide (2024).

The level of abaca production was computed as yield (kg) in one cropping season divided by the area of the abaca farm in measures in hectares. Table 2 presents the possible intervals that the level of abaca production might fall and its description.

Table 2. Level of abaca production.

Level of production[a]	Description
1 - 50	Low
51 - 100	Moderate
101 - above	High

Note: a - yield (kg) per hectare.
Source: Authors' guide (2024).

Before the survey was conducted, ethical processes were observed. The researchers have secured first a consent letter to the higher officials of each province, a letter of permission to conduct the survey, and informing them of the purpose and its significance. After the approval, a similar consent letter was sent to each municipality's offices addressed to the head personnel. Fortuitously, the study was permitted to be conducted in each targeted research locale. The survey was done through a face-to-face interview with the abaca farmers. In that case, before the interview, farmers were informed about the intent of the survey and told that no sensitive information would be collected. Moreover, they were also informed that the data collected from them will be treated as confidential which conforms to the Data Privacy Act in the Philippines and solely used for this article only.

Statistical Analysis and Empirical Model

Data collected has undergone clearing by excluding participants with missing responses and outliers. After this, qualitative responses were converted into quantitative data through the process of coding or assigning numerical values in Microsoft Excel. Additionally, the data were formatted in line with the STATA environment for statistical computations. To give an appropriate description of the data, it was summarized with standard statistical measures such as mean (M) as computed average, standard deviation (SD) as a measure of dispersion, coefficient of variation (CV) as a measure of consistency, minimum (min) and maximum (max) values, frequency counts (n) and percentages (%). The computed descriptive measures were presented by statistical tables. Note that the level of abaca production is categorically ordered, hence, the study employed ordinal regression modeling in determining the significant predictors. This study has constructed two empirical statistical models as follows:

$$AbacaProd_j = \rho_0 + \rho_1 Age_j + \rho_2 Male_j + \rho_3 Married_j + \rho_4 Yeduc_j + \rho_5 Oincome_j + \rho_6 AFarm_j + \rho_7 TStatus_j + \varepsilon_j \quad (1)$$

and

$$AbacaProd_j = \lambda_0 + \lambda_1 PhilFIDA_j + \lambda_2 SUCs_j + \lambda_3 LGU_j + \lambda_4 YFarming_j + \lambda_5 AgriAgency_j + \lambda_6 DHFarm_j + e_j \quad (2)$$

where $AbacaProd_j$ refers to the ordinal dependent variable (0-low, 1-medium, 2-high), j refers to the j[th] abaca farmer ($j \in \{1, 2, \ldots, 349\}$), ρ_j refers to the parameters to be approximated in the model (1), Age_j refers the age of abaca farmers in years, $Male_j$ represents a dummy variable that indicates a male abaca farmer (0-female, 1-male), $Married_j$ represents a dummy variable that indicates an abaca farmer who is officially married (0-non married, 1-married), $Yeduc_j$ refers to the farmers' number of years spent on education, $Oincome_j$ represents a dummy variable that indicates a farmer who has other income aside from abaca farming (0-None, 1-With other income), $AFarm_j$ refers to the farmer's area of abaca farm measured in hectares, $TStatus_j$ represents a dummy variable that indicates a farmer who owns their abaca farm (0-Not an owner, 1-Owner). Moreover, $PhilFIDA_j$ refers to the rating of farmers in their engagement with PhilFIDA (1 to 4 scaling), $SUCs_j$ refers to the rating of farmers in their engagement with SUCs (1 to 4 scaling), LGU_j refers to the rating of farmers in their engagement with LGU (1 to 4 scaling), $YFarming_j$ refers to the farmer's number of years in farming, $AgriAgency_j$ represents a dummy variable that indicates a farmer who was visited by agricultural agencies (0-Not visited, 1-Visited), $DHFarm_j$ refers to the distance from farmer's house to abaca farm measured in kilometers, and ε_i and e_j refers to the random errors in model (1) and (2), respectively. To capture that multicollinearity exists for independent variables, the variance inflation factor (VIF) was computed in each model (1 and 2) as a diagnostic test for regression analysis. The null hypothesis (H_o) of this study is that the independent variable has no significant influence on the dependent variable, otherwise the alternative hypothesis (H_a). All statistical computations were subjected to the probability of rejecting H_o with the standard level of significance.

RESULTS AND DISCUSSIONS

Profile of Abaca Farmers in Region VIII, Philippines

The descriptive statistics results for the abaca farmers' profile are presented in Table 3. Abaca farmers' mean average age is close to 51.49 (SD=12.18) years old where the youngest is 24 years old and the oldest is 90 years old. This finding is parallel to the paper in [9] that farmers are relatively old since their young ones are sent to school so that they can find a decent job with higher income. There are 73% male abaca farmers and 27% female abaca farmers. This result is consistent with the findings in [8], that there are more male farmers since farming job involves masculine activities. About 82% of the farmers were married and 18% of them were non-married (single, widower, etc.). The abaca farmers' number of years spent in education is approximately 7.81 (SD=3.47) years which indicates that, on average, they are high school level.

There exists a farmer in the survey that never experienced schooling and there are also farmers who are college-level. About 87% of the farmers have another source of income aside from abaca farming and only 13% of them are completely relying on abaca farming income. On average, the farm size cultivated for abaca farming is close to 1.88 ha (SD=2.36 ha), the minimum is 0.02 ha and the maximum is 30 ha. About 87% of the farmers owned their abaca farm and 13% of them did not own (tenants, workers, renting, etc.). The farmers' number of years in abaca farming is close to 21.18 (SD=14.52) where the minimum is 1 year and the maximum is 70 years. About 49% of the farmers said that they are visited by agricultural agencies or enablers for the production process and 51% of them said that they are never visited. The farmers' mean average distance from home to their abaca farm is close to 6.79 km (SD=16.10 km) where the minimum is 0.045 km and the maximum is 250 km.

Table 3. Abaca farmers' profile.

Variables	Mean (M)	SD	min	max
Age (years)	51.49	12.18	24	90
Male (dummy[a])	0.73	0.46	0	1
Married (dummy[a])	0.82	0.39	0	1
Education (years)	7.81	3.47	0	16
Other income (dummy[a])	0.87	0.33	0	1
Abaca farm size[b]	1.88	2.36	0.02	30
Abaca farm owner[a]	0.87	0.38	0	1
Years in abaca farming	21.18	14.52	1	70
Agency visit (dummy[a])	0.49	0.51	0	1
Distance from home to farm[c]	6.79	16.10	0.045	250

Note: a-indicator variable; b-in hectares (ha); c-in kilometers (km).
Source: Authors' statistical computation (2024).

Farmers' Engagement to Enablers

It is revealed in Table 4 that farmers have no direct engagement with the enablers in the region such that PhilFIDA (M=1.45, 0.87), SUCs (M=1.04, 0.28), and LGU (M=1.17, SD=0.57). The coefficient of variation (CV>20%) has shown that the response is not consistent which implies that farmers' perceptions can be changed depending on some factors. These results revealed that farmers do not interact with the other players in the abaca industry which is not ideal since they cannot gain information and new knowledge that is suitable for the current phenomenon. In fact, supporting actors who are extension service providers such as PhilFIDA, SUCs, and LGU play an important role, but they are not directly connected with the farmers in the value chain activities.Their direct involvement with the farmers only happens when they provide extension services such as capacity building.In this study, the researchers only made use of the frequency of meetings as an indicator of interaction between actors, thus the very minimal or no interaction result. Similar findings were also observed in [27] wherein abaca farmers in Catanduanes, Philippines sell directly to traders and it was recommended that they should connect to other actors in the value chain to reduce information asymmetry. Furthermore, the LGUs are advised to intervene in the chain through the creation of programs that would address sustainability in abaca production [23].

Table 4. Abaca farmers' engagement perception to enablers in Region VIII, Philippines.

Variables	M	SD	CV (%)	Interpretation
PhilFIDA[a]	1.45	0.87	60.00	No engagement
SUCs[a]	1.04	0.28	26.92	No engagement
LGU[a]	1.17	0.57	48.71	No engagement

Note: a-Scale 1 to 4.
Source: Authors' statistical computation (2024).

Abaca Production Level

Table 5 shows that 30.66% of the abaca farmers have experienced low production and about 22.92% have experienced a moderate level of production. This indicates that farmers need to be supported by other actors (PhilFIDA, SUCs, and LGU) to improve their abaca cultivation and production activities through innovative technologies. Unfortunately, a rapid production increase of abaca is difficult to achieve because of the Philippines' limited competitive advantages and the government initiatives have not been very successful in engaging abaca stakeholders [11].Additionally, there are 46.42% of the abaca farmers have experienced a high production level. This indicates that some farmers are fortunate regarding the production process since they have better production levels as opposed to other abaca farmers. On average, the mean production of the abaca industry in Eastern Visayas, Philippines can be interpreted as moderate level. Hence, abaca production in the region can still be improved. In [30], it is portrayed that strengthening the engagement between actors in the value chain is a broad-based approach to increasing abaca productionbecause it will not only maximize resources available but it will also synchronize the initiatives of SUCs, LGU, PhilFIDA, and other abaca stakeholders. In [11], it is stated that the convergence of abaca stakeholders allows the government to position and take advantage of possible increased demand for abaca and encourage chain upgrading into the energy and automotive sectors.

Table 5. Production level of abaca industry in Region VIII, Philippines.

Production Level	n	%
Low	107	30.66
Moderate	80	22.92
High	162	46.42
Mean production	Moderate	

Note: Production is yield (kg) per hectare (in one cropping season).
Source: Authors' statistical computation (2024).

Regression Models for Abaca Production

It is revealed in Table 6 that the first regression model (I) does not possess a multicollinearity problem based on mean VIF since it is less than 10 [2]. In that case, the model is acceptable for drawing conclusions and extracting inferences. It can be gleaned in Table 6, that model I (X^2=80.59, p-value<0.001) is significant at a 1% level and possesses a pseudo R^2 of 0.109 which indicates that there are some factors (predictors) that significantly influence the dependent variable which is the abaca production level. The model (I) showed that the following independent variables are not statistically significant: sex (p-value=0.137), civil status (p-value=0.301), educational attainment (p-value=268), other income (p-value=0.649), and tenurial status (p-value=0.840). This indicates that the said variables have minimal or no influence on the level of abaca production. On the other hand, age (ρ_1 =0.027, p-value=0.003) is highly significant at a 1% level. This indicates that the age of farmers is influencing the level of production in abaca farming. Since ρ_1>0, then this indicates that an older farmer has a higher probability of having a high level of production. In [18], it is portrayed that farmers with enough experience in farming tend to improve their knowledge, attitude, and practices in abaca cultivation which results in improved production practices and yield. The second predictor in the model (I) is abaca farm size (ρ_6=-0.564, p-value<0.001) which is highly statistically significant at a 1% level. Since ρ_6<0, this indicates that a smaller farm size in abaca is more likely to have a high production level. It is worth noting that a smaller farm can be easily managed and farmers can take care of the farm accordingly. In [16] and [22], it is depicted that a smaller farm size for abaca cultivation is more likely to be applied with new technologies and innovative approaches that improve abaca fiber production as opposed to bigger farms. Moreover, it is worth noting that bigger farms have more problems in growing abaca plants and have exhausting work to be accomplished by farmers [7], [19].

Table 6. Ordinal regression model I for the abaca production level and its possible factors.

Regressors	Coeff.	Std. Error	p-value	Interpretation
Age (years)	0.027*	0.009	0.003	Reject H_o
Male (dummy[a])	0.338^{ns}	0.227	0.137	Accept H_o
Married (dummy[a])	0.286^{ns}	0.278	0.301	Accept H_o
Education (years)	0.034^{ns}	0.031	0.268	Accept H_o
Other income (dummy[a])	0.147^{ns}	0.323	0.649	Accept H_o
Abaca farm size[b]	-0.564*	0.082	<0.001	Reject H_o
Abaca farm owner[a]	0.055^{ns}	0.273	0.840	Accept H_o
Survey participants	349			
$X^2_{computed}$	80.59^{ns}			
p-value (two-tailed)	<0.001			
Log-likelihood	-328.38			
Pseudo R^2	0.109			

Note: a-indicator variable; b-in hectares (ha); ns-not significant; *p<0.01.
Source: Authors'statistical computation (2024).

Table 7 depicted that the second regression model (II) does not suffer from multicollinearity problems based on mean VIF (i.e., VIF<10). This implies that there is no significant correlation exists in the pairwise of independent variables in the model (II) [2]. Thus, model (II) is accepted for making conclusions and inferences about the predictors of abaca production level. In addition, Table 7 portrayed that model II (X^2=9.60, p-value=0.142) is not significant even at the 10% level and it only possesses a pseudo R^2 of 0.013. This means that predictors in the model (II) have a minimal influence on the abaca production level. In fact, model II revealed that the following regressor variables are not significant: farmers' engagement with PhiliFIDA (p-value=0.185), SUCs (p-value=0.222), and LGU (p-value=0.796), agricultural agency visits (p-value=0.647), and farmer's distance from their house to their abaca farm (p-value=0.558).

Table 7. Ordinal regression model II for the abaca production level and its possible factors

Regressors	Coeff.	Std. Error	p-value	Interpretation
PhilFIDA[a]	0.200[ns]	0.151	0.185	Accept H_o
SUCs[a]	-0.457[ns]	0.374	0.222	Accept H_o
LGU[a]	-0.057[ns]	0.223	0.796	Accept H_o
Years in abaca farming	0.015*	0.007	0.038	Reject H_o
Agency visit (dummy[b])	0.101[ns]	0.221	0.647	Accept H_o
Distance from home to farm[c]	0.006[ns]	0.010	0.558	Accept H_o
Survey participants	342			
$X^2_{computed}$	9.60[ns]			
p-value (two-tailed)	0.142			
Log-likelihood	-356.67			
Pseudo R^2	0.013			

Note: a-Scale 1 to 4; b-indicator variable; c-in kilometers (km); ns-not significant; *p<0.05.
Source: Authors' statistical computation (2024).

This implies that the mentioned variables above are not influencing their abaca production level in a statistical sense. The findings of the study revealed that other players had no intention to increase their participating levels but relying on the value chain map alone is not enough and asking the other actors deeper questions about what is going on and why it is that way will lead back to some constraints they faced such as the case of PhilFIDA, SUCs and LGU personnel wherein the number field staff who are tasked to oversee and monitor the abaca farmers' production are inadequate [10]. However, model II has revealed that the number of years in abaca farming (λ_4=0.015, p-value=0.038) is statistically significant at the 5% level. Since λ_4>0, then it indicates that the farmers with long experience in abaca farming tend to improve their production level. This implies that the number of years of experience in abaca farming is a great help in applying innovative techniques and other competitive technologies that enhance abaca farming and improve production activities.

In [1], it is depicted that farming experience is a positive factor in adopting agricultural technologies that enhance farming techniques and maintain a sustainable production process. Moreover, in [6] and [15], it is portrayed that through farming experience, farmers become more knowledgeable about the different activities in farming which improves their practices by applying innovative technologies and competitive techniques in management systems.

CONCLUSIONS

The target of this article is to give a logical explanation of the level of production in abaca farming in Eastern Visayas, Philippines, and develop a statistical model that determines the influencing factors. Results showed that, on average, the production level of abaca farming in Eastern Visayas is considered as moderate. This concludes that the abaca production in the region is not fully enhanced and there is still room for increase given optimal processes and the right practices in farming. Descriptive statistics findings found that abaca farmers have no engagement (interaction) with enablers such as PhilFIDA, SUCs, and LGU due to some constraints and barriers. The reason behind this scenario is that there are only limitedresourcesandsupport from enablers which weakenstheabilitytoaddress manyconcerns and problems in the industry. In fact, the issue of the field technician-to-farmer ratio has been a troubling concern because abaca farmers are mostly located in mountainous barangays which are hardly reached by transportation. In addition, PhilFIDA along with SUCs and LGU field staff cover wider areas with each staff serving many municipalities, yet receives limited and delayed release of transportation incentives. Thus, farmers cannot expect field staff to visit them frequently. On top of these, field staff are burdened with other responsibilities. Hence, it is concluded that the government must support the abaca industry, particularly in Region VIII by providing more funds and agricultural extension agents to help the abaca farmers in progressing their production activities and maintain a sustainable business enterprise. In addition to that, the Philippine government must also support the PhilFIDA, SUCs, and LGU to initiate programs in the region that promote growth and development through production and extension supports, and educational training and seminar services.

The results of the statistical model concluded that the factors affecting the abaca production are the farmers' age and the size of the abaca farm. This implies that older farmer is more competitive and knowledgeable in applying innovative techniques and technologies that progress their production activities and solve agricultural problems. Meanwhile, the smaller size of abaca farms tends to give a higher yield since they can easily be managed and apply new technologies to improve production levels compared to larger abaca farms. Moreover, the second statistical model showed that farming experience is a significant predictor of abaca production level. This concludes that learned and experienced farmers are more productive and competitive in abaca farming. On the other hand, younger farmers are not that equipped in the farming system which leads to lower production. Conclusively, it is suggested that farmers should be trained and educated with different innovative discoveries in abaca cultivation techniques that solve farming problems and how to deal with agricultural constraints. It is recommended in future studies that the effectiveness of the agricultural extension and programs must be investigated and characterized by the abaca value chain analysis to enrich the current results of this study.

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