

1 **Field Trial on the Effects of Seedling Age, Yield and Economic Returns of Sahel 134 under**  
2 **Lowland Irrigated Ecology.**

3

4 **Abstract:**

5 In the Sahel and West Africa, the yields of rice are marginally low and other parts of the world, mainly attributed to  
6 soil-related constraints such as poor soil fertility, salinity, water management, poor land development and inadequate  
7 adherence to best agronomic practices. The objective of the research was to evaluate the growth, yield and economic  
8 returns of Sahel 134 rice variety in low land irrigated rice ecology. The research was conducted using a randomized  
9 complete block design (RCBD) with four (4) treatments 2, 3, 4,5 and control treatment. The data collected were  
10 analyzed using Microsoft Excel and analysis of variance (ANOVA). The results showed that percentage of ripened  
11 grains in the 2 and 5-weeks old seedling age is significantly higher of 80% than 2 weeks and control of 69% at 3  
12 weeks old. The Sahel 134 exhibited highest paddy yield from 3 weeks of 12.27 t/ha and obtained 13.02 t/ha at 5  
13 weeks while lowest yield scored was 9.82t/ha at 2 weeks respectively. The result shows that, with the production  
14 cost of D75,550 per hectare and the selling price of D20/kg. Furthermore, the results indicate that, at 5 weeks  
15 seedling performed optimally with significant improvement on yield and economic returns. In conclusion, at 5 weeks  
16 of seedling age enhances productivity and profitability of Sahel 134 rice variety with optimal economic returns. The  
17 research finding reveals implication to policy makers, researchers and rice farmers in their quest to improve on rice  
18 production, productivity and economic returns.

19 Keywords: Seedling age, yield, economic returns, irrigated ecology.

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30 **1. Introduction:**

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32 Rice (*Oryza Sativa*) is a semi-aquatic plant, and it is the only crop that can grow well on fields  
33 with different levels of flooding conditions. Rice requires specific growing conditions to be successfully  
34 cultivated. It must be grown in a flooded field in several inches of water. Rice is a staple food for over 3.5  
35 billion people worldwide (50%), with the majority of consumption occurring in Asia and Africa. The  
36 global demand for rice will be about 584 million tons or less towards 2050. With positive technological  
37 developments in the rice research arena, the shape of rice agriculture will change towards 2050. Asia may

38 lose about 5 million ha and Africa gain about 10 million ha of rice land by 2050 (Parshuram, S. *et al*;  
39 2021).The demand for rice in the Sub-Saharan Africa is continuously increasing. The worldwide rice  
40 consumption has seen a steady increase, reaching 520,437 thousand metric tons in 2022-2023 (Kavi  
41 Kumar K.S. 2021). Rice production in sub-Saharan Africa has been significantly affected by recurring  
42 droughts, which is more susceptible to when compared to other crops. In sub-Saharan Africa, rice  
43 production is primarily under rain fed conditions that rely primarily on rainfall pattern, making the crops  
44 vulnerable to droughts, floods and rising temperatures. Climate change intensifies soil salinity, and this  
45 greatly affects crop yield and the technical efficiency of rice farming (Oelviani, *et al*; 2024).

46 In many African countries, rice is considered a staple food and constitutes a major part of the diet.  
47 Globally, rice production is anticipated to increase a range of 58 to 567 metrics tons by 2030 (Mohidem,  
48 *et al*; 2022).Rice production in The Gambia is undertaken in different ecologies lowland rainfed, lowland  
49 irrigated (pump and tidal), hydromorphic conditions, upland rainfed, and swamps ecology (mangrove  
50 swamps). Food security can be maintained by enhancing crop yields through cultivating rice on limited  
51 land areas, particularly in The Gambia. As rice-based agro-ecosystems develop intensively, this adversely  
52 impacts environmental health. The intensively managed rice agro-ecosystem, known as a cropping  
53 system, has a number of unique properties due to which the application of agricultural technologies in rice  
54 farming is considered unusual in the global agronomy (Mohidem, *et al*; 2022). It is the staple food with a  
55 per capita consumption of 117 kg per annum, which is above the world average of 56.6 kg per annum.The  
56 annual requirement which is determined by the annual population increase stands at about 436,000 metric  
57 tons of paddy with a population of 2.2 million people in 2021 of which only 19% was locally produced  
58 and the deficit is met through importation (Luo *et al*; 2022). Rice is an important food crop and an  
59 emerging income crop for smallholder farmers.

60 The population of The Gambia is projected to increase to 3 million by people in 2030 with a  
61 projected increment in rice requirement to 552,000 metric ton of paddy(Parshuram *et al*; 2021).The mean  
62 yield at farmer level has increased significantly from 1-2 tons per hectare in the past decades to 2-3  
63 tons/per hectare in the upland conditions and 4-8 ton per hectare in the lowland irrigated rice fields due to  
64 the activities of the agricultural projects and government initiatives in the rice value chain. However,  
65 several constraints hinder the production and productivity of the rice sector in both ecologies. The  
66 lowland irrigated fields are affected by poor land development, poor water management (irrigation and  
67 drainage facilities), knowledge gaps in the effective utilization of fertilizers (fertilizer application rate and  
68 timing), planting density, seedling age, weeding frequency seed quality(Dossou and Saito, 2022). Rice is  
69 commonly grown by transplanting seedlings in lowland ecologies.

70 Several studies have shown that the ages of seedling at transplanting have a significant effect on  
71 the growth, yield, and economic return of rice. According to (Wang *et al*;2024) observed that seedling  
72 ages at transplanting had a significant effect on productive tillers per hill, post-transplant shock, and  
73 impact on yield components. Adoption of climate -smart agriculture practices such as improved rice  
74 varieties, soil and water conservation techniques, effective and efficient use of pesticides, and adjusting  
75 the planting and harvesting dates can increase yield by approximately 15.87% as well as incomes of  
76 farmers (Bijarniya, D.*et al*; 2020).Applying proper seedling age are among the good agricultural practices  
77 (GAPs) contributing to narrow down the existing yield gaps. Using older seedling ages affects rice  
78 growth, tillering pattern, vegetative and reproductive period while too young seedling ages creates  
79 seedling establishment problem mainly in waterlogged field conditions (Bijarniya, D. *et al*;2020).  
80 Therefore, this field trail was motivated by three issues; that is knowledge of interaction effects on growth  
81 performance, yield, and economic returns of Sahel 134 in making informed decision and by extension  
82 provide optimum paddy yield and highest profit margin.

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## 84 2. Materials and Methods:

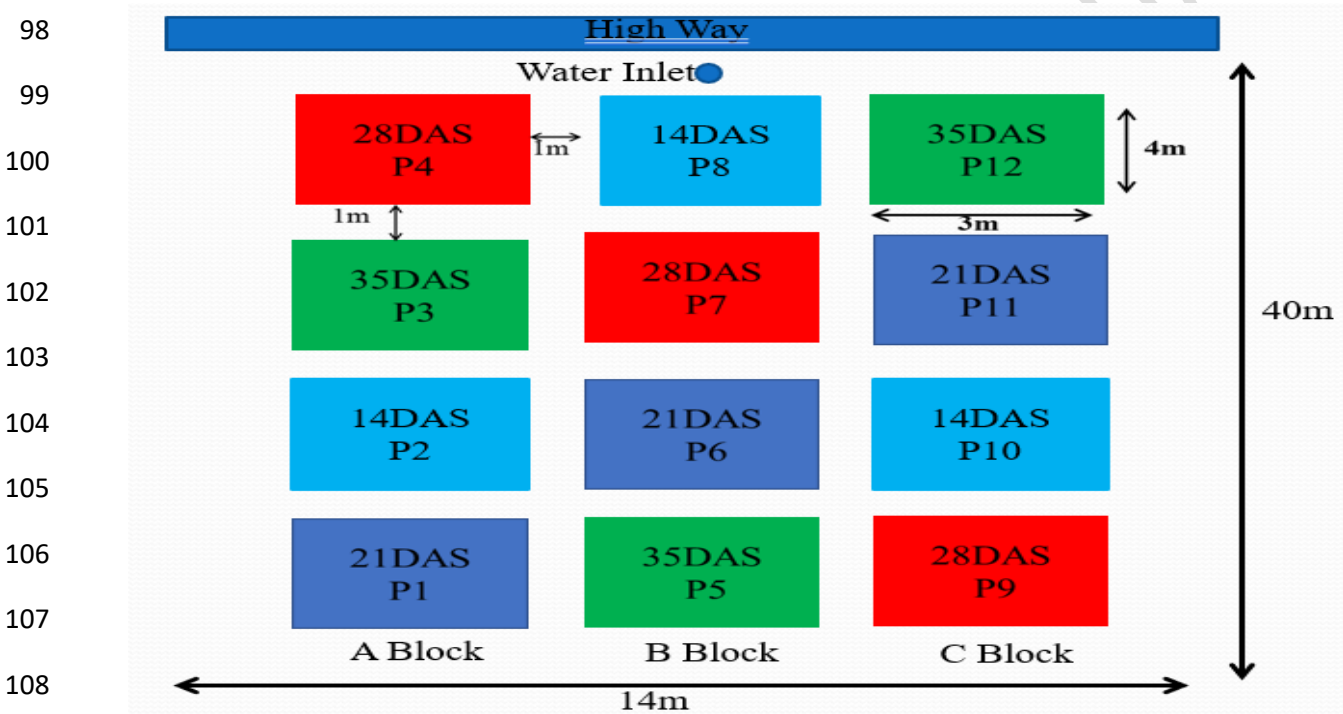
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### 86 2.1. Experiment Site Description

87 The experiment was conducted at the Sapu Agricultural Research Station, Central River Region (CRR),  
 88 of the from February to August 2025. The soil characteristics is a loamy clay soil and varying dry pattern  
 89 of high temperatures and high humidity period in which the experiment was conducted in an ideal  
 90 condition. The field trial was conducted under lowland irrigated rice ecology system with favorable  
 91 environmental condition.

92 *2.2. Experimental Design and layout*

94 | The experiment consists of one factor (seedling age) of four (4) treatments. The treatments were designed  
 95 in a randomized complete block design (RCBD) with three (3) replications, with each plot measuring 4m  
 96 x 3m, giving a total of 12m<sup>2</sup> plots. Each plot size was separated by 1m between plots and 1m between  
 97 blocks respectively.



109 Figure 1. Experimental Design and Layout

110 *2.3. Seed Treatment*

111 Rice seeds of Sahel 134 were pre cleaned and floated in water to remove empty grains. This was followed  
 112 by hot water treatment at 60<sup>0</sup>C for 10 minutes and soaked in warmwater for 5 minutes to simmer down.  
 113 The seeds of SAHEL 134 varieties were pre germinated for 48 hours at 25-30<sup>0</sup>C and seeds were sown  
 114 onnursery boxes measuring 60cm x 30cm with a sowing rate of 140 grams of seeds respectively.

117 *2.4. Field Preparation and Fertilizer Application.*

119 The land was prepared for cultivation using a tractor mounted with an arrow for ploughing and rotovator  
 120 for land levelling and evapotranspiration of the field. The fertilizers were applied according to the setup  
 121 of the field conditions and guided by rice farmer’s recommendations with an equal distribution across all  
 122 plots. This included an application of compound fertilize N, +P205, + K20(15:15:15)50kg/bag and Urea

123 46% 50kg/bag. In each bag of compound fertilizer N+P2O5, K2O. (15:15:15) 50kg/bag contained 7.5kg of  
 124 nitrogen (N), phosphorus (P), and potassium (K) respectively. In addition, in each bag of 50kg of urea  
 125 contained 23kg of nitrogen (N). In the process of fertilizer application 80% of N+P2O5, K2O (15:15:15)  
 126 was applied at basal dressing (-3DAT) and 20% at top dressing (47DAT), while 60% of urea was applied  
 127 at basal dressing (-3DAT) and 40% at top dressing (47DAT). Table 2. Shows fertilizer application rate  
 128 and timing.

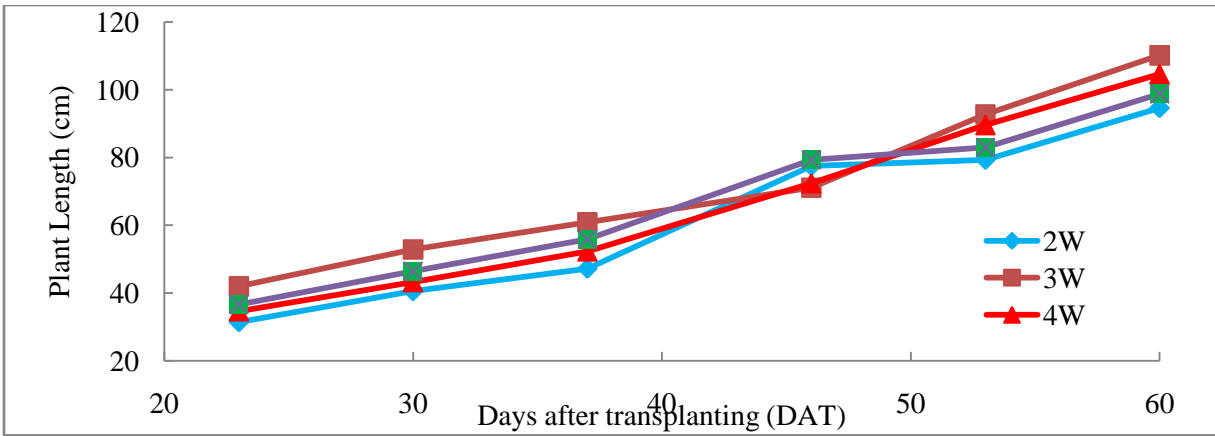
129 Table 1. Fertilizer application rate and timing.

Compound Fertilizer	Application Methods		Total number of fertilizer/kg
	Basal Dressing (-3daysbefore transplanting)	Top Dressing (47 days after transplanting)	
NPK	320 (80%)	80(20%)	400 (8bags)
Urea	90 (60%)	60 (40%)	150 (3bags)
Grand total			

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 131 *2.5. Data collection and Statistical Analysis:*  
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 133 In any field trial data collection is very key and important as it directs you to take decisive decisions or  
 134 make adequate projections to meaningful development initiatives. The data was collected on the growth  
 135 stages and yield component of Sahel 134. The parameters in growth observed were plant length (cm),  
 136 stem number, and leaf color. Data were almost collected at an interval of every 10 days from a total of  
 137 five (5) identified and labeled sample plants from each plot. Data were analyzed using Microsoft Excel  
 138 and analysis of variance (ANOVA) with Turkey's HSD Test (JMP ver.14.0).  
 139

140 **3. Results and Discussion:**

141 In field experimentation data collection, analysis and interpretation of the results is important for  
 142 projections for future development initiatives for appropriate decision making on policy matters. The  
 143 results from the field trial shows that, all the treatments demonstrated a steady increase in plant length  
 144 from active tillering stage to ripening stage as in [Figure 2](#). The mean plant height for Sahel 134 rice  
 145 varieties at 60 days after transplanting, the highest mean length of 110.1cm was recorded in the control  
 146 treatment (3 weeks) seedling age, 104.5cm recorded with 4 weeks treatment, 98.7cm was recorded at 5  
 147 weeks treatment while the smallest of 94.6cm was recorded at 2 weeks old treatments. Seedling age 3  
 148 weeks old scored a higher mean plant length, likely attributed to more advanced growth stage, greater  
 149 initial vigor, which helped to minimize post transplanting shock which could improve utilization of  
 150 nutrients resources and solar radiation. Within SRI, seedling age and crop geometry are key determinants  
 151 of yield and economic returns. Early transplanting of young seedlings maximizes tillering potential by  
 152 transplanting before the fourth phyllochron begins ([Kavi, 2021](#)). Statically, significant treatment effect  
 153 differences on plant length by seedling age were observed from 23DAT to 60DAT with a *p-value* 0.0009,  
 154 at *P*<0.05.



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156 Figure 2. Changes in plant length on Sahel 134 under different seedling ages:

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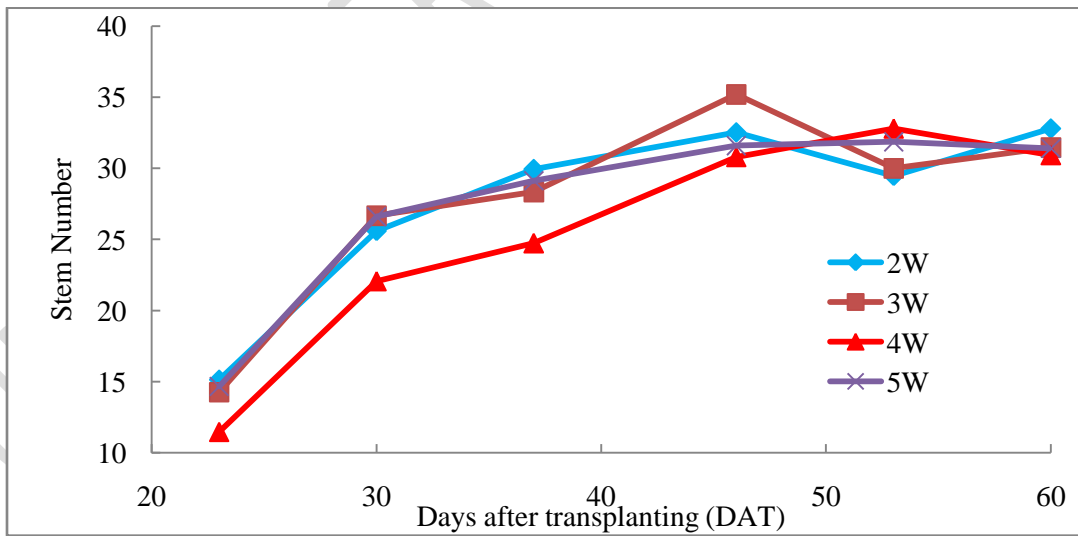
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In rice agronomy stem number and tillering is an integral component of crop physiology as it determines the yield potential in terms of grain composition (Mebrate, T. and Abdisa, 2023). The results in figure 3 shows that, Sahel 134 had rapid increment rapid increment in tiller number/m<sup>2</sup> from 23DAT-45DAT in all treatments 2, 3, 4, and 5 respectively. At 46-47DAT (top dressing), 3 weeks old seedling age started declining in tiller number while the remaining treatments (2, 4, and 5) recorded a slide increment not significantly different. A steady decline of tiller number/m<sup>2</sup> was observed in all treatments except the 2 weeks old seedling after the maximum tillering stage until the heading stage. This is attributed to the die-off of unproductive tillers with the highest treatments of 3, 4, and 5 as plants redirected energy from tiller production (vegetative stage) to panicle development and grain filling (reproductive stage). Variation occurred among the treatments due to the rate of decline, with some maintaining higher tiller number/m<sup>2</sup> than others. Treatment of 2 weeks old seedling age had relatively the highest tiller number/m<sup>2</sup>.



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172 Figure 3. Changes in Stem/Tiller Number/m<sup>2</sup> on Sahel 134 under different seedling ages.

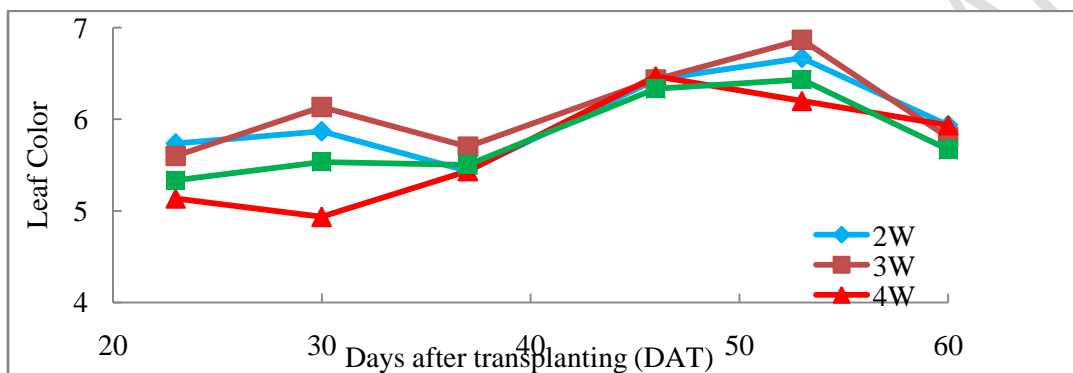
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In rice production and productivity, the leaf color is a morphological trait that reveals the photosynthetic activity and nutrient content of the rice plant (citation). The leaf color chart helps farmers decide when and how much nitrogen fertilizer to apply and is a visual cue for nitrogen content. As shown

176 in figure 3 the leaf color increase steadily from transplanting up to maximum tillering stage. A week from  
 177 top dressing fertilizer application, there was a consistent increase in leaf color across the treatments, with  
 178 3 weeks all seedlings showing a greater increase compared to others. According to (Mupeta et al; 2022) at  
 179 53DAT (heading), all treatments, showed a marked decrease in leaf color, indicating a reduction in  
 180 nitrogen levels as the rice crop approached the harvesting period. This also indicates the leaf (source  
 181 organ) had started supplying photosynthetic products to sink (panicles and grains). Moreover, the  
 182 ANOVA results indicated that the interaction had no statistically significant effect on Leaf Color.  
 183 Moreover, the ANOVA results indicated that the interaction had no statistically significant effect on leaf  
 184 color



185  
 186 Figure 4. Changes on leaf color on Sahel 134 under different seedling ages.

187 In the process of rice production yield is primarily is determined by four key components of  
 188 panicles per unit area, spikelet per panicle, percentage of filled spikelets and individual grain weight.  
 189 These, along with other factors like tillers per hill and panicle length directly influence the final grain  
 190 while optimal management of these components is crucial for achieving high, sustainable, and profitable  
 191 rice production (Wang et al; 2024). The results from the research findings in Table 2 showed that the  
 192 interaction of the seedling age on yield components, difference in panicle number among seedling ages  
 193 was not statistically significant ( $p > 0.05$ ).

194 However, the difference in grain number per panicle and the difference in 1000-grain weight  
 195 among seedling ages are statistically significant, whereas the difference in percentage of ripened grains  
 196 among seedling ages was highly significant. The highest mean panicle number of 31.3 happened at a  
 197 seedling age of 5 weeks with a grain number of 108.3ab influences a greater yield of gram per meter  
 198 square of (1302), despite the difference was not statistically significant for panicle number. The lowest  
 199 yield occurred at 2 weeks and 4 weeks old seedling ages as shown in Table 2 and Figure 5. According to  
 200 (Liang et al. 2025) if temperatures exceed 30 °C for more than five consecutive days during the grain-  
 201 filling stage, aleurone layer development is suppressed and starch accumulation is impaired, resulting to  
 202 poor grain formation.

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210 Table 2. Effect of treatments on grain yield and yield components.

Seedling age (Week)	Panicle (#of hills)	Grain number (#/panicle)	Percentage (%) ripened grains	1000-grain (g/1000-grain)	Yield (g/m <sup>2</sup> )
2	23.3	94.0b	80.1a	25.3ab	982
3	27.4	112.7a	69.4bc	25.8ab	1227
4	25.1	109.2ab	65.2c	28.4a	1128
5	31.1	108.3ab	78.8ab	21.9b	1302
<i>P-value</i>	0.0708	0.0317	0.0003	0.0089	

211 Note 1: Figures followed by the same letter are not significantly different at P=0.05 by Turkey's HSD  
212 Test

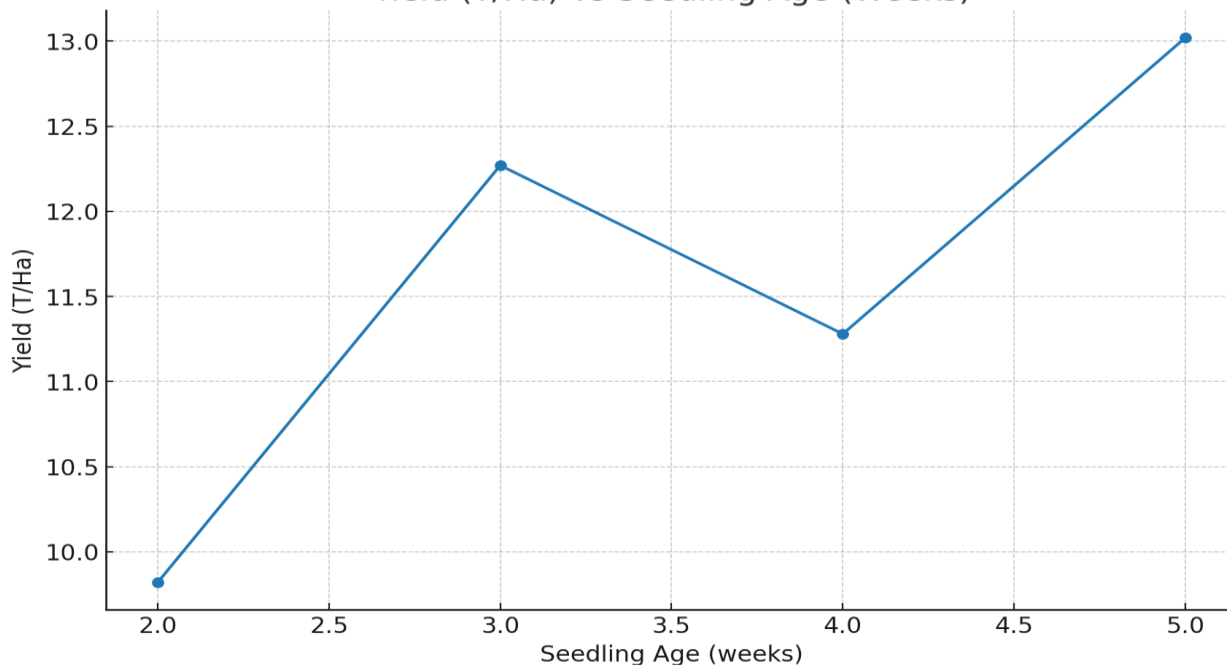
213 ANOVA: Analysis of Variance

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215 Further, discussion and interpretation of the results data, it is equally important to see the interaction  
216 between the yield (t/ha) and seedling age in weeks. The results in Figure 5 showed that, at the seedling  
217 age of 3 weeks 12.3 tons/ha was obtained while seedling age of 4 weeks slightly obtained 11ton/ha. The  
218 highest tons/ha scored was 13ton/ha at the seedling age of 5 weeks. In rice production and productivity  
219 high yields above 10ton/ha under control environment would determine the level of food and nutrition  
220 security in a given country (Sah et al; 2023).

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Yield (T/Ha) vs Seedling Age (Weeks)



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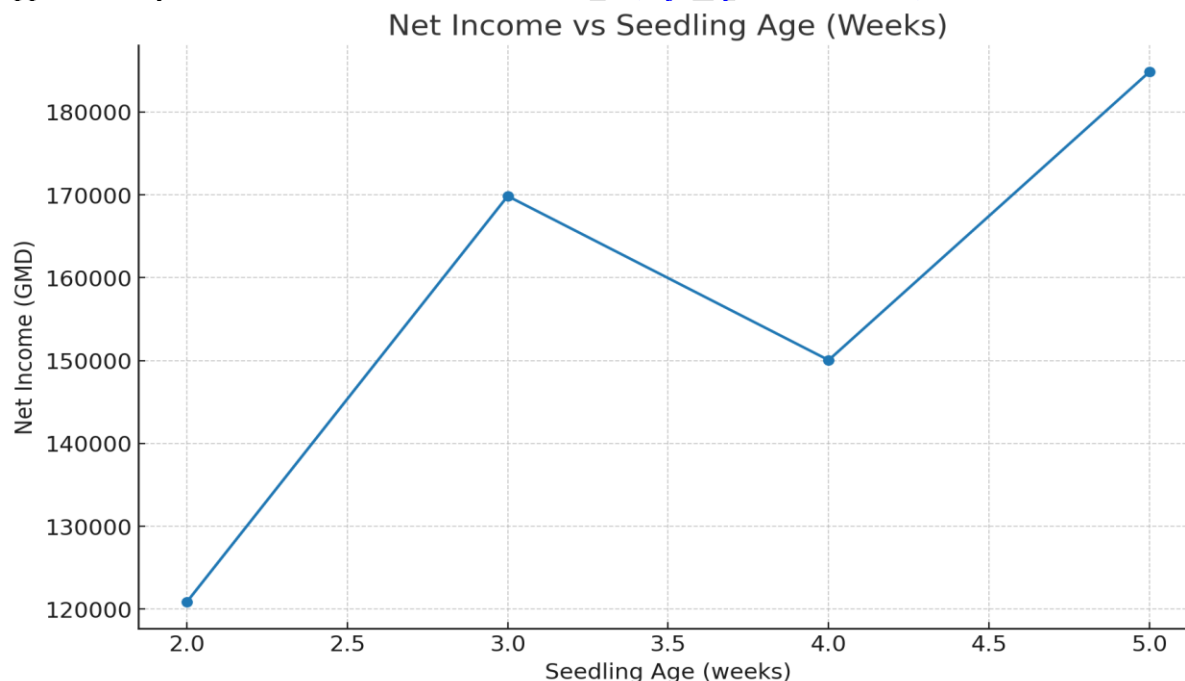
238 The production cost-benefit analysis which comprises of the fixed costs and variable costs is a  
239 crucial tool in the production of Sahel 134 rice. It helps farmers and policymakers evaluate the  
240 profitability and efficiency of different production systems. By comparing the costs of various inputs,  
241 outputs, and practices, cost of production analysis can reveal the optimal allocation of resources and the

242 best strategies for improving productivity and sustainability. From table 5 the results indicate superior  
 243 profitability for transplanting 3 weeks and 5 weeks old is more profitable provided that management is  
 244 adequate. Seedling age of five weeks delivers the highest net incomes and favorable BCRs, with adequate  
 245 agronomic management for older transplants (Champness, et al; 2023).

246 Table 3. Results of cost-benefits analysis of Sahel 134 rice variety.

Seedling age (weeks)	Yield (t/ha)	Revenue (GMD)	Net income (GMD)	BCR	ROI	Profit margin (%)
2	9.82	196,400	120,850	2.60	1.60	61.5
3	12.27	245,400	169,850	3.25	2.25	69.2
4	11.28	225,600	150,050	2.99	1.99	66.5
5	13.02	260,400	184,850	3.45	2.45	71.0

247  
 248 In the interpretation of the results in Figure 4 showed that, at the seedling age of 3 weeks scored  
 249 net income D170,000 while net income declined to D150,000 net income. Further, the most outstanding  
 250 net income obtained was above D180,000 at the age of 5 weeks. The relationship between net income and  
 251 seedling age in agriculture is typically inverse, with younger seedlings generally producing higher net  
 252 income due to better establishment, higher tillering, and greater crop yield. Adoption of climate -smart  
 253 agriculture practices such as improved rice varieties, soil and water conservation techniques, effective and  
 254 efficient use of pesticides, and adjusting the planting and harvesting dates can increase yield by  
 255 approximately 15.87% as well as incomes of farmers (Bijarniya D, et al; 2020).



256  
 257 Figure 6: Relationship between seedling age and net income

258 **4. Conclusion and Recommendation:**

259 In developed and developing countries rice as a crop is widely grown and consumed in the Sahel  
 260 and West African countries in which is not exceptional. The government and the Ministry of Agriculture,

261 Livestock and Food Security have set series of development priorities especially in the area of rice  
262 production. The policy direction is shifting from subsistence to commercialization towards the attainment  
263 of rice self-sufficiency in a medium term. The trial research trial was conducted in Sapu Research  
264 Agricultural Station with the ultimate objective was evaluate the growth, yield and economic returns of  
265 Sahel 134 rice variety in low land irrigated rice ecology. The research was conducted using a randomized  
266 complete block design (RCBD) with four (4) treatments 2, 3, 4,5 and control treatment. The data  
267 collected were analyzed using Microsoft Excel and analysis of variance (ANOVA x) JMB (ver.14.0). The  
268 results revealed that, at the age of 2 to 5 weeks suggests under normal trial conditions, older transplants  
269 experienced less transplanting shock and had greater initial biomass and root capacity to support rapid  
270 post-transplant establishment. These advantages likely increased tiller survival and panicle number per  
271 unit area, translating into higher yields and returns. The results from the research findings in Table 2  
272 showed that the interaction of the seedling age on yield components, the difference in panicle number  
273 among seedling ages was not statistically significant ( $p>0.05$ ).

274 Furthermore, at 5-weeks of seedling age obtained the best results while under normal conditions  
275 very old seedlings can reduce tillering potential or increase lodging risk affecting the yield component.  
276 The economic robustness and sensitivity revealed that the benefit-cost ratios (BCRs) exceed 3.45 for the  
277 top treatments indicating wide profit margins under better selling price 20 GMD/kg) and cost structure.  
278 The results showed that percentage of ripened grains in the 2- and 5-weeks old seedling age is  
279 significantly higher of 80% than 2 weeks and control of 69% at 3 weeks old. The Sahel 134 exhibited  
280 highest paddy yield from 3 weeks of 12.27 t/ha and obtained 13.02 t/ha at 5 weeks while lowest yield  
281 scored was 9.82t/ha at 2 weeks respectively. Importantly, operationalize 3-5 weeks transplanting window,  
282 farmers will require reliable nursery management uniform seedling trays or well managed seedbeds, that  
283 is timely land preparation, and assured water management and nutrients. Where labor is a constraint,  
284 labor-saving arrangements (group transplanting, mechanized transplanting where feasible) can support  
285 adoption without eroding profitability. In conclusion, the research results revealed that, the practical  
286 window of 3-5 weeks is advisable for smallholder farmers to adopt the new technology with suitable  
287 temperature, adequate water regime and proper seedling management. The research recommends to  
288 conduct similar trial on the application of different fertilizer rates on different rice varieties.  
289

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302 paper.  
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