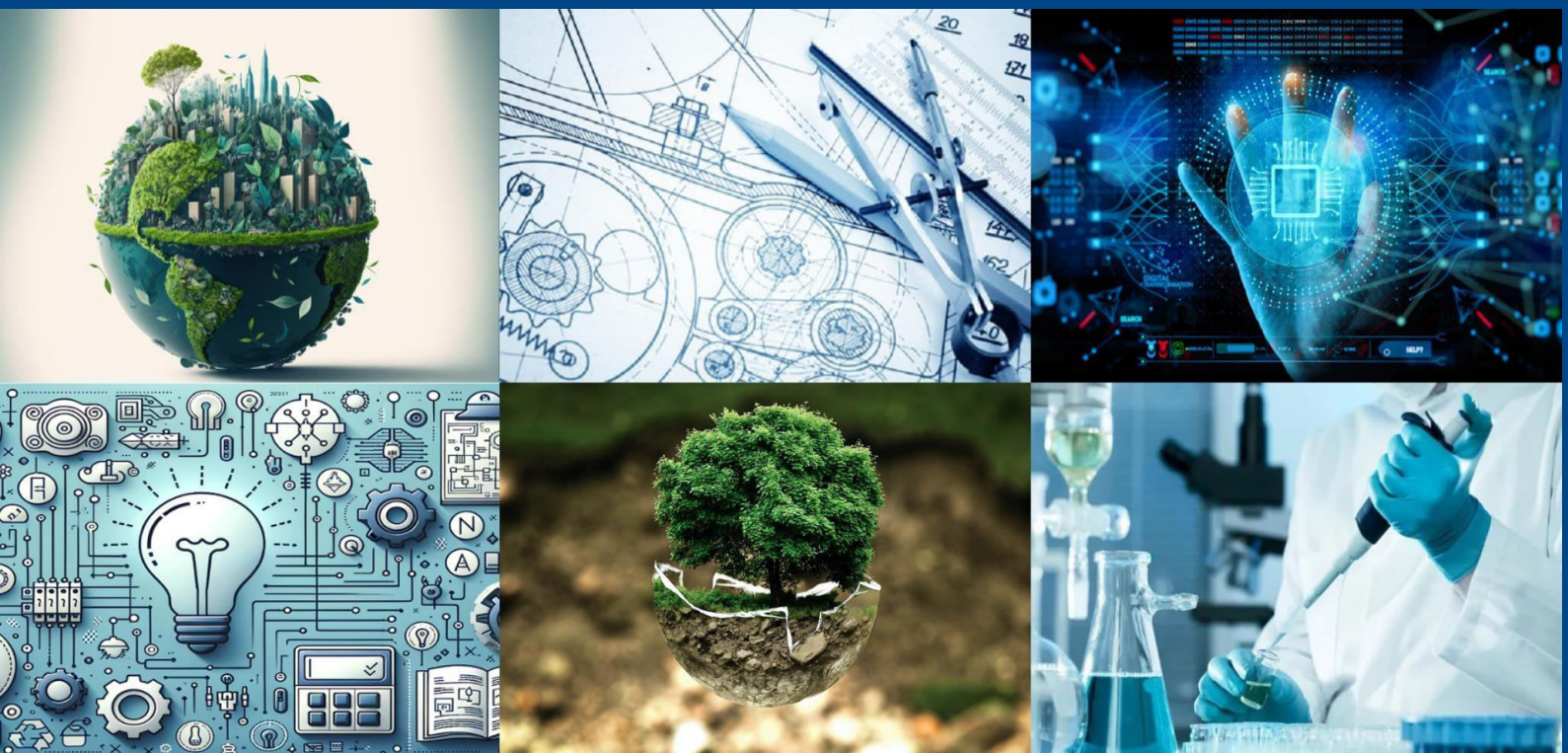




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Nutritional Interventions and Their Effectiveness in Improving Health Outcomes of Tribal Adolescent Girls in Model Residential Schools of Wayanad

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ABSTRACT: Nutritional interventions in Model Residential Schools play a crucial role in addressing the health needs of tribal adolescent girls in Wayanad district of Kerala. This paper evaluates the effectiveness of various interventions, including school meal programs, micronutrient supplementation, and nutrition education, on key health outcomes. The study analyses changes in anthropometric indicators, prevalence of anaemia, and overall physical development among girls benefiting from these programs.

Findings indicate moderate to significant improvements in nutritional status and reduction in anaemia prevalence among regular participants. School-based feeding programs have contributed to better dietary diversity and increased intake of essential nutrients. However, the impact varies depending on the duration of stay, cultural acceptability of interventions, and complementary household nutrition practices. Some persistent challenges include incomplete coverage of micronutrient needs and limited long-term sustainability of gains after girls leave the residential system.

The analysis highlights the importance of culturally sensitive and comprehensive approaches that combine food-based interventions with education and community involvement. Model Residential Schools provide a unique opportunity for intensive nutritional support during the critical adolescent period. Strengthening these interventions through better monitoring, menu diversification, and family engagement can lead to more substantial and lasting improvements in health outcomes.

The study underscores the potential of school-based nutritional programs as an effective strategy for addressing malnutrition among tribal adolescent girls while emphasising the need for sustained efforts beyond the school environment.

KEYWORDS: Nutritional interventions, Tribal adolescent girls, Model Residential Schools, Wayanad, Anaemia, Dietary diversity, Health outcomes, School meal programs

I. INTRODUCTION

Tribal adolescent girls in India face significant nutritional challenges that affect their physical growth, cognitive development, and long-term health. In Wayanad district of Kerala, indigenous communities such as Paniya, Kurichiya, and others experience high rates of undernutrition, anaemia, and micronutrient deficiencies. Limited access to diverse foods, traditional dietary patterns, poverty, and geographical isolation contribute to these problems. Adolescence is a critical period of rapid growth and development, making adequate nutrition particularly important for building nutritional reserves for future reproductive health. However, many tribal girls enter this phase already compromised by childhood undernutrition, creating a cycle of poor health outcomes that is difficult to break without targeted interventions.

Model Residential Schools established by the Government of Kerala provide a unique and controlled environment for addressing these nutritional challenges. These schools offer not only education but also comprehensive care, including structured meal programs, health check-ups, and a safe living space away from some of the hardships of remote tribal hamlets. The residential setting allows for consistent delivery of nutritional interventions, regular monitoring of health parameters, and exposure to balanced diets that may not be available in home environments. These schools serve as important platforms for testing and implementing nutrition-sensitive programs that can significantly influence the health trajectory of tribal adolescent girls during their formative years.



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The relevance of studying health outcomes in the Wayanad context is multifaceted. Wayanad is home to several Particularly Vulnerable Tribal Groups with distinct cultural practices and high levels of marginalization. The district's hilly terrain, high rainfall, and forest-based economy create specific nutritional challenges and opportunities. Understanding how school-based interventions work in this unique setting can provide valuable insights for similar tribal areas across the country. It also helps in assessing whether residential school models are effective in breaking the intergenerational cycle of malnutrition among tribal populations.

This examination of nutritional interventions and their impact on health outcomes contributes to the broader goal of empowering tribal girls through improved health and education. Better nutritional status during adolescence can lead to improved learning outcomes, better reproductive health in adulthood, and stronger future generations. The study highlights both the achievements and the remaining gaps in current approaches, offering directions for strengthening these important initiatives in tribal residential schools.

II. NUTRITIONAL INTERVENTIONS IN RESIDENTIAL SCHOOLS

Nutritional interventions in the Government Model Residential Schools of Wayanad district are designed to provide comprehensive support to tribal adolescent girls during their critical growth years. The core component is the school meal program, which includes hot cooked meals served during lunch and supplementary snacks in the morning and evening for hostel students. These meals typically consist of rice as the staple, accompanied by dal, seasonal vegetables, and occasional non-vegetarian items such as eggs or fish. The menu is planned to meet the recommended dietary allowances for adolescents, with special attention to protein, iron, and calcium-rich foods. Mid-day meals are prepared in school kitchens following standardised recipes, ensuring consistency in portion sizes and nutritional content.

Supplementary nutrition initiatives complement the main meal program. Many schools provide milk or milk-based products daily to address calcium requirements. Fortified foods, including iron-fortified rice or wheat, are incorporated to tackle widespread micronutrient deficiencies. Seasonal fruits and sprouts are included whenever possible to enhance vitamin intake and dietary diversity. These supplementary items are particularly important for girls who may have limited access to such foods in their home environments.

Micronutrient supplementation forms another key pillar of the intervention strategy. Weekly or bi-weekly iron-folic acid tablets are distributed to combat anaemia, which is highly prevalent among tribal adolescent girls. Vitamin A supplementation is provided periodically to support vision and immune function. Deworming tablets are administered regularly to improve nutrient absorption. Health education sessions conducted by teachers and visiting health workers focus on topics such as balanced diet, personal hygiene, menstrual health, and the importance of regular meals. These sessions help in creating awareness and encouraging positive behavioural changes.

Integration of local foods and culturally appropriate approaches has been increasingly emphasised in recent years. Schools have started incorporating traditional tribal foods such as ragi, tubers, and locally available greens into the menu. This not only improves acceptance but also supports local farmers and preserves cultural food heritage. Community involvement in menu planning ensures that meals respect tribal food preferences and avoid items that may be culturally restricted. Some schools have developed kitchen gardens where students grow vegetables, creating both nutritional and educational benefits.

The residential school environment facilitates better implementation of these interventions compared to day schools. Continuous supervision, peer learning, and a structured daily routine contribute to higher compliance with nutritional guidelines. Regular health check-ups and growth monitoring allow for early identification and management of nutritional problems. The combination of food-based interventions, supplementation, and education creates a synergistic effect that addresses multiple aspects of nutritional well-being.

These interventions represent a holistic approach to nutrition that goes beyond mere calorie provision. They aim to correct existing deficiencies, prevent new ones, and build healthy eating habits that can last beyond the school years. The success of these programs depends on several factors, including quality of implementation, cultural relevance, and coordination with other health and education initiatives. Understanding the various components of these interventions provides the foundation for evaluating their overall effectiveness in improving health outcomes among tribal adolescent girls in Wayanad district.



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III. HEALTH OUTCOME INDICATORS

Health outcome indicators provide concrete evidence of the effectiveness of nutritional interventions in the Model Residential Schools of Wayanad district. Anthropometric measurements are the most commonly used tools to assess physical growth and nutritional status. Height-for-age, weight-for-age, and Body Mass Index (BMI) are regularly monitored among the tribal adolescent girls. Many girls show steady improvement in height and weight after joining the residential schools, indicating the positive effect of consistent and balanced nutrition. However, a significant proportion still exhibit mild to moderate stunting, reflecting the long-term impact of chronic undernutrition experienced in early childhood before entering the school system.

Growth patterns reveal interesting trends across different age groups. Younger adolescent girls (11-14 years) generally show faster catch-up growth in weight and height compared to older girls (15-18 years). This suggests that early intervention during the pubertal growth spurt yields better results. BMI trends indicate a reduction in thinness among regular participants, though some girls remain in the borderline category due to high physical activity levels and genetic factors. Regular monitoring has helped in early identification of growth faltering cases, allowing for timely corrective measures.

The prevalence of anaemia remains a major concern despite ongoing interventions. Haemoglobin levels have shown improvement in many girls due to regular iron-folic acid supplementation and better dietary iron intake through school meals. However, moderate anaemia continues to affect a notable percentage of students, particularly those who have recently joined the schools or have poor compliance with supplements. Other micronutrient deficiencies, such as vitamin A and calcium, are also observed, though their severity has decreased with the inclusion of fortified foods and diverse vegetables in the school diet.

Overall physical health indicators have shown positive changes. Reduced frequency of common infections, better energy levels, and improved skin and hair health are commonly reported among girls with better nutritional status. The residential school environment, with its focus on hygiene and regular medical check-ups, has contributed to these improvements. Regular deworming and health education have played supporting roles in enhancing physical well-being.

Menstrual health is an important indicator for adolescent girls. Better nutritional status has been associated with more regular menstrual cycles and reduced incidence of severe dysmenorrhea. Improved iron status has helped in reducing anaemia-related fatigue during menstruation. However, challenges remain in providing adequate sanitary facilities and education on menstrual hygiene in some schools.

Cognitive development indicators, though less directly measured, show promising trends. Teachers report better concentration, memory, and classroom participation among girls with improved nutritional status. Reduction in anaemia and better overall energy levels appear to support cognitive functions. Long-term studies would be needed to establish clearer links between nutritional interventions and academic performance.

These health outcome indicators collectively demonstrate that nutritional interventions in residential schools have produced measurable positive effects. The improvements are more pronounced in girls who have stayed longer in the system and have good compliance with the programs. However, persistent challenges such as stunting and anaemia indicate that current interventions need further strengthening and integration with other health and family-level initiatives. Regular and comprehensive monitoring of these indicators is essential for continuous program improvement and ensuring better health outcomes for tribal adolescent girls in Wayanad district.

IV. EFFECTIVENESS OF INTERVENTIONS

The effectiveness of nutritional interventions in the Model Residential Schools of Wayanad district can be assessed through changes in nutritional status before and after implementation. Many girls show noticeable improvements in anthropometric parameters after joining the schools. Weight gain and increase in BMI are commonly observed within the first few months of consistent meal consumption. Height velocity also improves, particularly among younger adolescents who benefit from the catch-up growth opportunity. These physical changes are more prominent in girls who come from severely food-insecure households, indicating that school-based interventions fill critical nutritional gaps.



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Micronutrient status shows mixed but generally positive trends. Haemoglobin levels have improved in a significant proportion of girls due to regular iron supplementation and better dietary intake. The prevalence of moderate to severe anaemia has decreased, though mild anaemia persists in some cases. Vitamin A status has shown improvement with the inclusion of vegetables and occasional supplementation. However, the response to interventions varies widely among individuals, with some girls showing rapid recovery while others require longer periods of consistent support.

Factors influencing the success of different interventions include duration of stay, compliance with supplementation, cultural acceptability of meals, and complementary home nutrition. Girls who have stayed in the residential system for more than two years generally show better outcomes compared to new entrants. Regular participation in all meals and supplements leads to more substantial improvements. Cultural factors play a crucial role – interventions that incorporate locally familiar foods tend to have higher acceptance and better results. Family support and regular home visits also influence how well the girls maintain the gained nutritional benefits.

Comparative analysis across different schools and tribal groups reveals interesting variations. Schools with better infrastructure, trained kitchen staff, and active community involvement show superior outcomes. Some tribal groups adapt more easily to the school diet due to greater exposure to diverse foods, while others take longer to adjust because of strong traditional food preferences. Schools located closer to market centres have better access to fresh produce, leading to more varied menus and better nutritional results compared to more remote schools.

The overall effectiveness of interventions is evident in improved school attendance, better classroom performance, and enhanced physical activity levels among the girls. However, the sustainability of these gains after completion of schooling remains a challenge. Many girls experience some regression in nutritional status when they return to their villages, highlighting the need for continued support systems and family-level nutrition education.

These findings suggest that while school-based nutritional interventions are effective tools for improving health outcomes, their success depends on multiple interconnected factors. A comprehensive approach that combines food-based interventions with education, supplementation, and community engagement yields the best results. Continuous monitoring and adaptive management are essential for maximising the effectiveness of these programs in the unique context of tribal residential schools in Wayanad district.

V. CHALLENGES IN IMPLEMENTATION AND SUSTAINABILITY

Implementation of nutritional interventions in the Model Residential Schools of Wayanad district faces several barriers that limit optimal utilization and impact. One of the primary challenges is cultural acceptability of the provided meals. Many tribal girls come from communities with strong traditional food preferences and taboos. Certain vegetables or preparation methods used in school kitchens may not align with their cultural practices, leading to partial consumption or food wastage. This reduces the overall nutritional benefit despite regular provision of meals. Language barriers and limited involvement of local elders in menu planning further contribute to lower acceptance in some schools.

Logistical constraints in the hilly and remote terrain of Wayanad add to implementation difficulties. Irregular supply of food grains, vegetables, and other ingredients affects menu consistency and quality. Transportation challenges during monsoon seasons often delay deliveries, forcing schools to use alternative or less nutritious options. Storage facilities in many schools are inadequate, leading to spoilage and wastage of perishable items. These logistical issues are more pronounced in schools located in interior tribal hamlets compared to those nearer to main roads.

Socio-cultural constraints play a significant role in program utilization. Some girls hesitate to fully participate in meals due to social stigma or preference for familiar home foods. Peer group dynamics can sometimes lead to selective eating behaviours where popular items are consumed more while nutritious but less preferred items are left uneaten. Gender norms and traditional beliefs around food in certain tribal communities also influence how girls engage with the school meal program.

Long-term sustainability of nutritional gains after school completion is a major concern. Many girls experience some regression in nutritional status when they return to their villages and resume traditional dietary patterns. The transition from the structured school environment to home settings often leads to reduced dietary diversity and inconsistent meal



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timings. Limited economic resources and lack of continued nutrition support at the family level make it difficult to sustain the improvements achieved during school years.

Other challenges include inadequate monitoring mechanisms and limited capacity of school staff. Regular assessment of nutritional status and meal quality is not consistently carried out in all schools. Kitchen staff often lack formal training in nutrition and hygiene practices. Coordination between different departments (education, tribal welfare, health) remains weak, affecting the integration of various interventions.

Financial constraints also limit program effectiveness. Many schools operate with limited budgets that restrict the inclusion of more expensive but nutritious items such as fruits, milk, and eggs on a regular basis. Dependence on central and state government funding leads to delays and uncertainty in resource availability.

Despite these challenges, the residential school system offers unique opportunities for intensive nutritional support. Addressing the identified barriers through better community engagement, improved logistics, capacity building, and sustained family-level support can significantly enhance the long-term impact of these interventions on the health and well-being of tribal adolescent girls in Wayanad district.

VI. FINDINGS AND DISCUSSION

The analysis of nutritional interventions in the Model Residential Schools of Wayanad district reveals several major outcomes and patterns. One of the most consistent findings is the improvement in anthropometric indicators among tribal adolescent girls who have stayed in the residential system for longer periods. Weight gain and increase in BMI are commonly observed, particularly during the initial two years of school stay. Height velocity also shows positive trends, though stunting remains a challenge for many girls due to the long-term effects of early childhood undernutrition. These physical improvements are more pronounced in girls coming from severely food-insecure households, indicating that school-based interventions effectively address critical nutritional gaps.

Dietary habits have shown noticeable positive changes. Increased consumption of pulses, vegetables, and dairy products has led to better dietary diversity compared to traditional home diets. Regular meal timings and exposure to balanced plates have helped in developing healthier eating behaviours. Micronutrient status, particularly iron levels, has improved in a significant proportion of girls due to supplementation and better dietary intake. However, complete resolution of anaemia remains elusive in some cases due to compliance issues and other contributing factors.

Critical insights emerge regarding the role of residential schools in nutritional improvement. The controlled environment, structured meal programs, and continuous supervision provide an ideal setting for intensive nutritional support during the crucial adolescent growth phase. The schools act as a bridge between traditional tribal food systems and modern nutritional requirements, gradually introducing diversity while respecting cultural sensitivities. Peer learning and nutrition education sessions have been effective in shaping long-term dietary behaviours.

However, the findings also highlight important limitations. The impact is stronger on short-term indicators such as weight gain and energy levels, while long-term issues like stunting show slower progress. The transition from school to village life often leads to partial reversal of nutritional gains, underscoring the need for continued family and community-level interventions. Variations across different tribal groups and schools indicate that cultural factors and implementation quality significantly influence outcomes.

The study brings forth the insight that residential schools serve as powerful platforms for nutritional recovery but cannot work in isolation. Their effectiveness is enhanced when complemented by efforts to improve household food security and community awareness. The geographical and socio-cultural context of Wayanad requires tailored approaches that integrate local knowledge with scientific nutrition principles.

Overall, the findings affirm that well-implemented nutritional interventions in residential schools can significantly contribute to better health outcomes among tribal adolescent girls. However, achieving sustainable and comprehensive nutritional improvement requires a multi-level approach that addresses both school-based and home-based factors. These insights provide valuable guidance for strengthening existing programs and designing future interventions in similar tribal contexts.



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VII. POLICY SUGGESTIONS AND WAY FORWARD

Strengthening nutritional interventions in Model Residential Schools requires focused policy recommendations at multiple levels. The Government of Kerala should increase dedicated funding for school nutrition programs in tribal areas to ensure regular supply of diverse and high-quality food items. This includes establishing a special nutrition fund for tribal residential schools with flexibility for incorporating locally available nutritious foods. Regular revision of menu guidelines to include more traditional tribal foods can improve cultural acceptability and nutritional value simultaneously.

Strategies for better integration should focus on convergence between different departments. Close coordination between the Department of Tribal Welfare, Education, Health, and Women & Child Development can create synergistic effects. Integrating school meal programs with the National Health Mission for regular health check-ups and deworming can enhance overall impact. Linkages with the Public Distribution System can ensure steady supply of essential food grains at subsidised rates for school kitchens.

Monitoring mechanisms need significant strengthening. A digital dashboard for real-time tracking of meal quality, consumption patterns, and nutritional outcomes should be implemented across all residential schools. Regular nutritional assessments using standardised tools should be conducted at least twice a year. Community monitoring committees involving parents and tribal leaders can provide grassroots-level feedback and improve accountability.

Future directions for scaling up effective models should focus on evidence-based expansion. Successful practices from high-performing schools, such as incorporation of local foods and community involvement, should be documented and replicated. Development of a comprehensive nutrition manual specifically for tribal residential schools can standardise quality while allowing for local adaptations. Pilot projects on fortified foods and ready-to-eat nutritious supplements suitable for tribal contexts should be encouraged.

Capacity building remains crucial for long-term success. Regular training programmes for cooks, teachers, and school administrators on nutrition, hygiene, and menu planning should be institutionalised. Development of training modules in local tribal languages can improve effectiveness. Creating a cadre of nutrition counsellors who can work specifically with tribal communities can provide sustained support.

Policy suggestions should also address the broader determinants of nutrition. Promotion of kitchen gardens, small livestock rearing, and sustainable agriculture practices in tribal hamlets can complement school-based efforts. Strengthening the Public Distribution System to include more nutritious items in tribal areas is equally important for improving household food security.

The way forward lies in transforming residential schools into model nutrition and health promotion centres. This requires political commitment, adequate financial resources, inter-departmental coordination, and active community participation. Continuous learning, regular evaluation, and adaptive management will be essential for achieving meaningful and sustainable improvements in the nutritional status of tribal adolescent girls in Wayanad district and similar regions across the country.

VIII. CONCLUSION

Nutritional interventions in the Model Residential Schools of Wayanad district have demonstrated considerable potential in improving the health and nutritional status of tribal adolescent girls. The structured provision of balanced meals, micronutrient supplementation, and nutrition education have contributed to better dietary diversity, weight gain, and reduction in anaemia prevalence among many participants. The residential school environment has provided a supportive setting for consistent nutritional support during the critical adolescent growth phase.

However, the study also highlights important challenges and limitations. Cultural acceptability, logistical constraints, and limited household-level support affect the overall effectiveness and long-term sustainability of these interventions. While short-term improvements are visible, sustaining nutritional gains after girls complete their schooling remains a significant concern.



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The findings emphasise that residential schools can serve as powerful platforms for nutritional recovery when interventions are culturally sensitive, well-implemented, and adequately monitored. The geographical and socio-cultural context of Wayanad requires approaches that respect tribal traditions while introducing modern nutritional principles.

Moving forward, strengthening these interventions through better community involvement, improved monitoring systems, and integration with family-level nutrition programs can enhance their impact. Policy support for comprehensive, context-specific nutritional strategies in tribal residential schools is essential for addressing the persistent problem of malnutrition among tribal adolescent girls.

In conclusion, well-designed and effectively implemented nutritional interventions in Model Residential Schools offer a promising pathway for improving health outcomes and empowering tribal girls. Sustained commitment and adaptive management will be key to realising their full potential in promoting better nutrition and brighter futures for tribal communities in Wayanad district and beyond.

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