

ORIGINAL RESEARCH



Multifunctional uses of *Bidens pilosa* L. among rural households in Malawi

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Abstract

Introduction

Indigenous and underutilized plant species play an important role in food security, health, and livelihoods in Sub-Saharan Africa, yet their multifunctional contributions are often underexplored. This study examines the nutritional, medicinal, economic, and cultural-spiritual uses of *Bidens pilosa* L. among households in Malawi using a novel Quadri-Power Framework.

Methods

Household survey data from 400 participants were analysed using descriptive statistics, mean comparison tests, and binomial logistic regression in Jamovi and JMP software. Qualitative data collected from key informant interviews and focus group discussions were analysed using thematic analysis in NVivo.

Results

The results show that *Bidens pilosa* is widely utilized for both nutritional and medicinal purposes, with users exhibiting significantly higher perception scores than non-users. Economic engagement through cultivation varied across socio-demographic groups, with the perception index emerging as a significant predictor of cultivation. Cultural and spiritual uses were evident, particularly among older respondents, highlighting the plant's embeddedness within local belief systems and social structures.

Conclusion

The study findings demonstrate that *Bidens pilosa* serves a role beyond that of a wild or marginal species, contributing significantly to nutrition, primary healthcare, livelihoods, and cultural identity. These findings highlight the capacity of indigenous plants to enhance resilient food systems, promote sustainable livelihoods, and inform culturally relevant development strategies in Malawi and similar contexts in Sub-Saharan Africa.

Keywords: African leafy vegetables; household livelihoods; indigenous food systems; traditional medicine; underutilized plant species.

Introduction

Indigenous wild and underutilized plant species are essential for enhancing rural livelihoods, promoting dietary diversity, and facilitating traditional healthcare in Sub-Saharan Africa^{1,2,3,4,5}, particularly for low-income households reliant on local biodiversity for sustenance and medicinal purposes. These species are often embedded within traditional agroecological knowledge systems^{4,5}, yet remain underrepresented in formal agricultural research and policy frameworks.

African leafy vegetables (ALVs) have gained renewed attention due to their high nutritional value and multifunctional roles in rural livelihoods. They are acknowledged for their significant nutrient density and their role in providing essential vitamins, minerals, and phytochemicals vital for human nutrition and health which are frequently deficient in staple-based diets prevalent in SSA^{6,7,8}. Furthermore, these crops contribute to resilient food systems by diversifying diets and reducing dependence on staple crops under climate stress conditions⁴. Despite these benefits, their integration into mainstream food systems remains limited due to weak value chains, low commercialization, and persistent perceptions of these species as "poor man's food" or weeds.

Bidens pilosa L., known as *Bidens pilosa* or wild spinach, is a widely consumed indigenous leafy vegetable in various regions of Sub-Saharan Africa, including Malawi. It serves both as a food source and for medicinal applications^{4,9}. Phytochemical investigations have identified numerous bioactive compounds, such as polyphenols, flavonoids, and various metabolite classes, linked to anti-inflammatory, antioxidant, antidiabetic, and antimicrobial properties^{10,11,12}. The properties indicate that *Bidens pilosa* may serve as a functional food and a natural therapeutic agent.

Recent studies indicate that *Bidens pilosa* serves both culinary and medicinal purposes, having been employed for centuries as a remedy for various diseases^{8,23,35}. *Bidens pilosa* has a significant history of application in traditional medicine among various cultures, especially in Africa, Asia, and South America^{6,10}. It has been utilized in the management of various conditions including malaria, respiratory disorders, and dermatological issues³. Extracts from *Bidens pilosa* demonstrate antimicrobial properties, which may be advantageous in addressing bacterial and fungal infections²⁴. *Bidens pilosa* possesses bioactive compounds that may bolster the immune system and enhance the body's capacity to fight infections and diseases²³. It enhances skin health and

may aid in the treatment of conditions thereby promoting overall health and well-being^{15,22}. *Bidens pilosa* demonstrates potential in enhancing digestive health and mitigating gastrointestinal disorders⁹.

Bidens pilosa may contribute to the development of new pharmaceuticals³⁴, potentially resulting in revenue generation and job creation. The cultivation of *Bidens pilosa* presents economic opportunities for farmers, especially in areas conducive to its growth and where there is a demand for its medicinal properties. *Bidens pilosa* has potential applications in the production of nutraceutical products and herbal tea³⁹. Nigeria, Benin, and Zimbabwe cultivate *Bidens pilosa* on a small scale for medicinal purposes²⁴.

At the regional level, studies from countries such as Zimbabwe, Nigeria, and Benin further illustrate the multifunctional importance of *Bidens pilosa* and similar underutilized plants. These studies show that such species contribute simultaneously to nutrition, traditional medicine, and income generation through informal markets and small-scale processing^{13,24}.

Although there is growing acknowledgment of its nutritional and medicinal value, research on *Bidens pilosa* continues to be largely disjointed. Current research primarily focuses on either laboratory-based biochemical profiling²² or descriptive ethnobotanical inventories regarding knowledge and traditional use. There is a scarcity of studies that integrate multiple dimensions of use within a single analysis, and contextual evidence from Malawi remains notably limited.

Numerous studies outline the traditional medicinal applications of *Bidens pilosa* and other indigenous leafy vegetables^{32,37}; however, they fail to systematically analyse the translation of these applications into household-level nutritional practices or their economic and cultural relevance within daily life systems. The existing literature is deficient in comprehensive data regarding the integration of the plant within economic activities, such as cultivation, value addition, and income generation, as well as cultural or spiritual practices that influence community engagement with *Bidens pilosa*. This gap highlights a crucial aspect of the plant's multifunctionality that remains underexplored, especially regarding rural livelihoods and socio-cultural resilience.

This study employs a Quadri-Power framework to conceptualize *Bidens pilosa* as a multifunctional plant, encompassing four interrelated dimensions of use: nutritional, medicinal, economic, and cultural-spiritual. The study offers a comprehensive evaluation of *Bidens pilosa*'s role in food systems, traditional healthcare, and livelihood diversification in Malawi by focusing on actual household practices instead of mere awareness. The study specifically aims to: (1) examine the nutritional and medicinal applications of *Bidens pilosa* within households; (2) assess its economic contributions to household livelihoods, including cultivation and income generation; and (3) explore the cultural and spiritual practices linked to its use in local communities.

This study presents an integrated, practice-oriented analysis that examines multiple functional domains of *Bidens pilosa*, providing comprehensive empirical evidence from Malawi, a region where such multifaceted studies are limited. This method transcends knowledge inventories to quantify and characterize actual usage patterns, thereby enhancing comprehension of the plant's wider socio-economic and cultural importance in Sub-Saharan African food and health systems.

Methodology

Study site and design

This study was carried out in the Lilongwe district of Malawi, focusing on four Extension Planning Areas (EPAs): Chitsime, Mkwinda, Ngwangwa, and Ukwe. The selected EPAs provide a suitable basis for comparison, as two are situated in urban areas and the other two in rural communities of Lilongwe. The potential for commercialization of *Bidens pilosa* in Malawi's capital city is significant. This research employed a cross-sectional mixed-method design to achieve a thorough understanding utilizing both qualitative and quantitative approaches. The design was employed to gather data through both quantitative and qualitative methods, facilitating simultaneous analysis while preserving their autonomy¹¹.

The study incorporated the Quadri-Power Framework by conceptualizing *Bidens pilosa* as a multifunctional plant encompassing four interrelated dimensions of use: nutritional, medicinal, economic, and cultural-spiritual. The four dimensions informed the study design, the formulation of specific objectives, and the interpretation of findings. Each dimension was regarded as a separate but interrelated analytical domain, enabling the study to transcend singular characterizations of the plant. This framework offered a comprehensive perspective for analysing household engagement with *Bidens pilosa*, effectively incorporating its material, socio-economic, and cultural values within a unified analytical structure.

Sampling techniques

The sample size was determined using Yamane's formula⁴¹, based on a known population of approximately 126,473 farming households, as reported by the agricultural extension development office in the study area, with a margin of error of $\pm 5\%$. The determined sample size comprised 400 farming households. The sample distribution within each EPA was determined by calculating the proportion of each EPA relative to the total number of farming households: Chitsime EPA (21.6%), Mkwinda EPA (21.8%), Ngwangwa EPA (32%) and Ukwe (24.6%). Random sampling was conducted utilizing the Microsoft Random Function in Excel to select survey participants from the farming household list obtained from each EPA. Consequently, random sampling provided each farming household an opportunity to participate in the study, thereby reducing bias.

Six key informants were purposively selected to obtain detailed information regarding the study area. The number of key informants was established based on the saturation point. The selection of participants for the focus group discussions was conducted purposively with an emphasis on gender equality. Two focus groups were conducted in each EPA with farming households, resulting in a total of eight focus group discussions, each comprising a minimum of 8 and a maximum of 10 members.

Data collection

Data were collected through a structured household questionnaire, interview guide and focus group discussion check list developed in accordance with the Quadri-Power Framework. The data collection tools comprised modules aligned with the four dimensions, gathering data on household practices concerning nutritional consumption, medicinal use, economic activities (including cultivation

and income generation), and cultural–spiritual applications of *Bidens pilosa*. Socio-demographic variables, including sex, age, education level, group membership, and primary livelihood activity, were collected to facilitate disaggregated and multivariate analysis. This systematic method guaranteed alignment between the conceptual framework and the empirical data collected. The perception questions in the mentioned dimensions were collected utilizing a five-point Likert scale consisting of the following options: (1) strongly disagree, (2) disagree, (3) no opinion, (4) agree, and (5) strongly agree, arranged sequentially. The questionnaire was programmed in Kobo Toolbox and administered via computer tablets and smartphones through face-to-face interaction with respondents to ensure high-quality data. Qualitative data were collected via semi-structured interviews and focused discussions to examine multiple functional domains of *Bidens pilosa*.

Data management and analysis

Data analysis followed the Quadri-Power structure by applying appropriate quantitative and qualitative techniques to each dimension of use. Quantitative data were analysed utilizing Jamovi 2.6.44 and JMP 18.1. Descriptive statistics summarized household engagement with *Bidens pilosa* across nutritional, medicinal, economic, and cultural-spiritual dimensions. Frequencies and proportions were calculated to characterize usage patterns by sex, age group, group membership, and occupation. Mean perception index scores were computed to evaluate respondents' valuation of *Bidens pilosa* across various use categories. Independent samples t-tests were utilized to compare perception scores between users and non-users of the plant for nutritional, medicinal, and economic purposes. Cross-tabulations were utilized to analyse variations in the reported use of *Bidens pilosa* across socio-demographic categories such as sex, age group, group membership, and primary activity.

A binomial logistic regression model was estimated to identify factors associated with the cultivation of *Bidens pilosa* for economic purposes. The dependent variable was household engagement in the cultivation of *Bidens pilosa* for economic purposes, coded as 1 for yes and 0 for no. Independent variables comprised socio-demographic and institutional factors, along with perceptions of the value of *Bidens pilosa*. The model variables were coded as follows: gender (1 = male, 0 = female); age (in years); education (in years of schooling); group membership (1 = member, 0 = non-member); primary activity (1 = agriculture, 0 = otherwise); and perception (continuous index score).

The logistic regression model was specified as equation 1¹²:

$$\begin{aligned} \text{logit}(P) = & \beta_0 + \beta_1(\text{Gender}) + \beta_2(\text{Age}) + \beta_3(\text{Education}) \\ & + \beta_4(\text{Group membership}) + \beta_5(\text{Primary activity}) \\ & + \beta_6(\text{Perception index}) + \epsilon \end{aligned}$$

where P represents the probability that a household cultivates *Bidens pilosa* for economic purposes, β_0 is the intercept, β_1 – β_6 are the estimated coefficients for the explanatory variables, and ϵ is the error term. Regression results were reported as odds ratios with corresponding 95% confidence intervals and p-values. The reliability and adequacy of the binomial logistic regression model were assessed using several diagnostic measures. Overall model fit was evaluated with the likelihood ratio chi-square test, which indicated that the included explanatory variables significantly improved prediction

of household engagement in *Bidens pilosa* cultivation for economic purposes compared to the null model. Model explanatory power was examined using Cox and Snell and Nagelkerke pseudo R² statistics²⁰. In addition, model classification accuracy demonstrated acceptable predictive performance. Multicollinearity diagnostics showed low variance inflation factor values for all predictors, indicating stable coefficient estimates and overall model reliability³⁸.

Statistical tests were performed at a significance level of 5% ($p < 0.05$). The reliability of the perception scale was evaluated through Cronbach's alpha²¹. The reliability analysis showed that the perception scale had excellent internal consistency, with a Cronbach's alpha of 0.945²¹. This confirms that all items measuring community perceptions of *Bidens pilosa* are highly reliable. All graphical visualizations were conducted using Jamovi 2.4.

Qualitative data collected from in-depth interviews and focus group discussions were transcribed verbatim and analysed thematically using NVivo 14. Thematic analysis involved iterative coding, the categorization of codes into sub-themes, and the integration of these into overarching themes²⁹. This process enabled the identification of recurring patterns in four interrelated dimensions of *Bidens pilosa* uses: nutritional, medicinal, economic, and cultural-spiritual and local interpretations of the value of *Bidens pilosa*. Qualitative and quantitative findings were integrated to enhance validity and provide a comprehensive understanding of the study topic. By applying consistent analytical logic across all four dimensions, the study operationalized the Quadri-Power Framework as both a conceptual and analytical tool for assessing the multifunctional role of *Bidens pilosa*.

Results

Socio-economic characteristics of the study respondents

The study included 72% female participants and 28% male participants. Most of the study participants (87.3%) were married, while 4.8% were widowed, 6.3% divorced, and 1.8% single. Regarding the highest level of education achieved, approximately 87% of respondents completed primary education, while 13% completed secondary education. Approximately 54.3% of the study participants were involved in agricultural cooperatives or associations. Approximately 86.3% of the study participants engage primarily in agriculture, while 7.2% depend on casual labour and 6.5% are involved in business activities. In terms of age group, youth between 18 and 35 years were 45.3%, adults between 36 and 55 37.3% and older adults above 55 years were 17.5%. The mean age of the respondents was 40 years.

Nutritional and medicinal uses of *Bidens pilosa* among households

The findings demonstrate that *Bidens pilosa* is extensively utilized for medicinal purposes within households in the study area. Quantitative analysis indicates that 70.9% of respondents from both genders reported the common use of *Bidens pilosa* in traditional medicine. When analysed by sex, male respondents represented a marginally greater percentage of users (73%) than female respondents (70%). The medicinal application of *Bidens pilosa* has been documented in individuals of all age demographics.

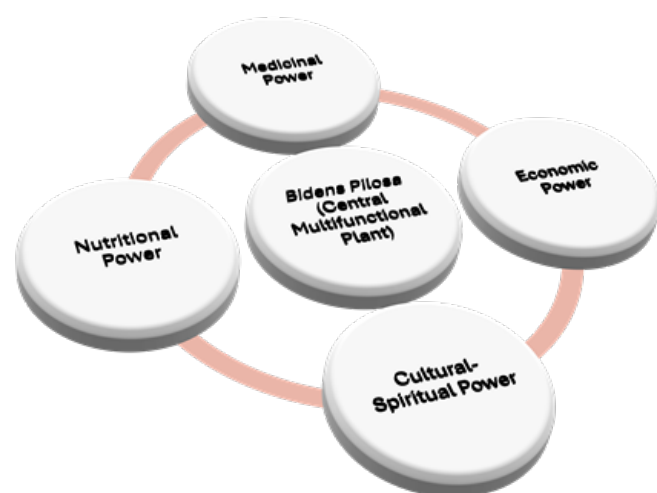
Table 1. Comparison of mean perception index scores between users and non-users of *Bidens pilosa* for nutritional and tradition medicinal purposes (t-test results)

Group	Mean	SD	p
Non-users	3.54	0.778	<.001
Users	4.32	0.610	

Table 2. Binomial logistic regression analysis of socio-demographic and perception factors influencing household cultivation of *Bidens pilosa* for economic purposes in Lilongwe District, Malawi

Predictor	Estimate (β)	SE	Z	p	Odds ratio	95% Confidence Interval	
						Lower	Upper
Intercept	-9.1252	1.4993	-6.086	<.001	1.09e-4	5.76e-6	0.00206
Gender	0.3629	0.3456	1.050	0.294	1.437	0.7301	2.83011
Age	-0.0212	0.0101	-2.088	0.037	0.979	0.9598	0.99871
Marital status	-1.2875	0.5444	-2.365	0.018	0.276	0.0949	0.80210
Education	0.0728	0.4281	0.170	0.865	1.075	0.4647	2.48910
Group membership	0.5751	0.3136	1.834	0.067	1.777	0.9612	3.28639
Occupation	0.4539	0.4239	1.071	0.284	1.574	0.6860	3.61337
Perception index	2.7250	0.3074	8.865	<.001	15.257	8.3525	27.86884

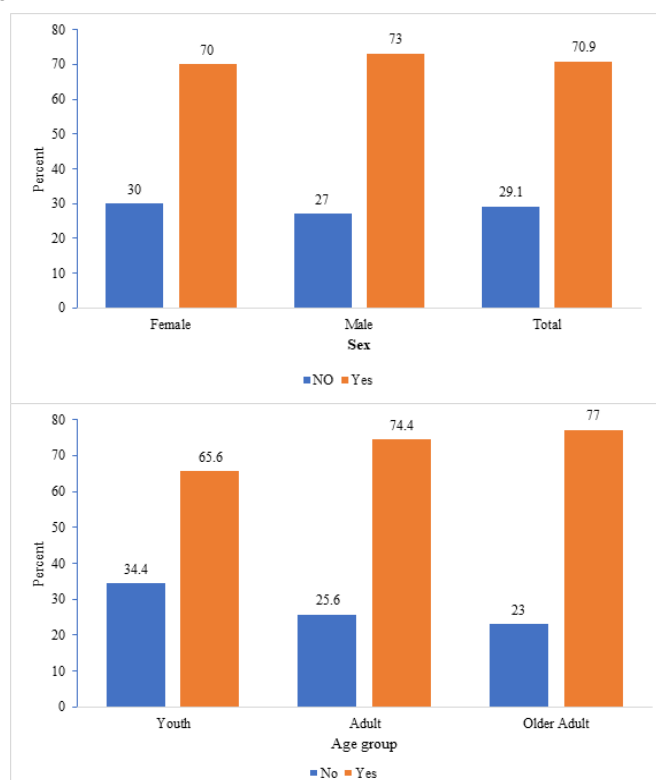
Estimates represent the log odds of "Cultivation = 1" vs. "Cultivation = 0"

**Figure 1. Conceptual diagram of the Quadri-Power Framework showing the four interconnected dimensions of *Bidens pilosa* utilization: nutritional, medicinal, economic, and cultural-spiritual**

The prevalence of use increased with age, peaking at 77% among respondents over 55 years, followed by those aged 36–55 years (74.4%), while younger respondents exhibited comparatively lower usage (65.6%). This suggests that the medicinal use of *Bidens pilosa* is more prevalent among older members of the household.

There are notable differences in perception regarding the nutritional and medicinal use of *Bidens pilosa* between users and non-users. The findings demonstrate a statistically significant difference in mean perception scores between the two groups. Households utilizing *Bidens pilosa* exhibited a higher mean perception index ($M = 4.32$, $SD = 0.610$) than non-users ($M = 3.54$, $SD = 0.778$). The t-test results indicate a statistically significant difference ($p < 0.001$), suggesting enhanced positive perceptions of nutritional and medicinal value among users.

From the qualitative study, it was found that *Bidens pilosa*, locally known as 'Kazota', is commonly used as a leafy vegetable and in juice preparation known as "Kazota juice". *Bidens pilosa* is prepared in various ways; crushed, boiled, and dried for future use. Cooking methods aim to preserve nutrients as they perceived that the plant contains vitamins and iron. "We boil *Bidens pilosa* and make Kazota (*Bidens pilosa*)

**Figure 2. Prevalence of *Bidens pilosa* traditional medicinal use among households in Lilongwe District, Malawi, disaggregated by (A) sex and (B) age group**

Juice and put in a bottle and drink in the morning, afternoon and evening", one respondent narrated. The respondents reported that they eat *Bidens pilosa* leafy vegetables as a source of body nutrients. They use *Bidens pilosa* leafy vegetables and Kazota (*Bidens pilosa*) juice in combating malnutrition in children. "This is what we do when we want to be helped nutrition wise: we do not boil a lot, we just boil a little bit then drink its water, then use the leaves served with nsima", one of the FGD participants explained.

In the study area, *Bidens pilosa* is believed to have medicinal properties such as boosting immunity and treating different ailments passed down through traditional knowledge.

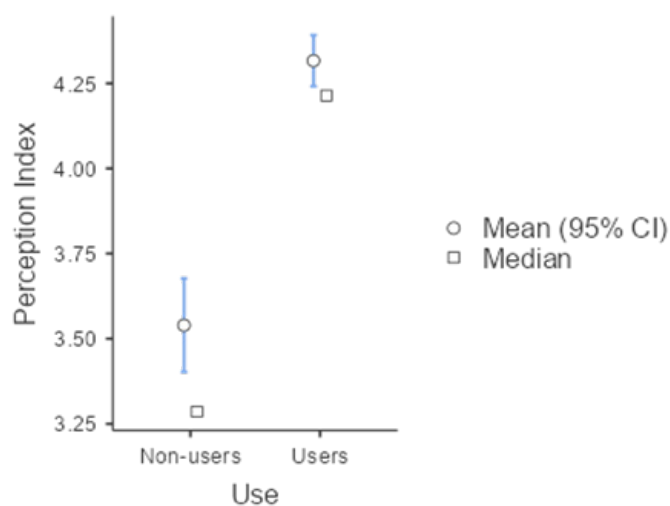


Figure 3. Distribution of perception index scores comparing users and non-users of *Bidens pilosa*. Users exhibit significantly higher perception scores, indicating stronger awareness and valuation of the plant's nutritional and medicinal benefits

The respondents reported that *Bidens pilosa* is used to cure ailments such as malaria, stomach pains, coughs, wounds, menstrual irregularities, 'mauka' /schistosomiasis (vaginal candidiasis), 'chipere' (skin infection), chlamydia, eye infection, 'masungu', 'nyamakazi' and pregnant complications.

For pregnant complications, the respondents narrated that "freshly plucked leaves are chewed by pregnant women to prevent complications, including the premature death of the unborn baby". In treatment of eye infection, one of the FGD participants narrated that "I was experiencing eye infections and sought medical attention at the hospital, but my condition did not improve. However, after using *Bidens pilosa* leaves, I experienced healing, and now my eyes are clear". According to the respondents, the *Bidens pilosa* leaves are squeezed, and its water is applied in the infected eyes to facilitate healing.

The crushed *Bidens pilosa* leaves are applied to wounds to facilitate the healing process.

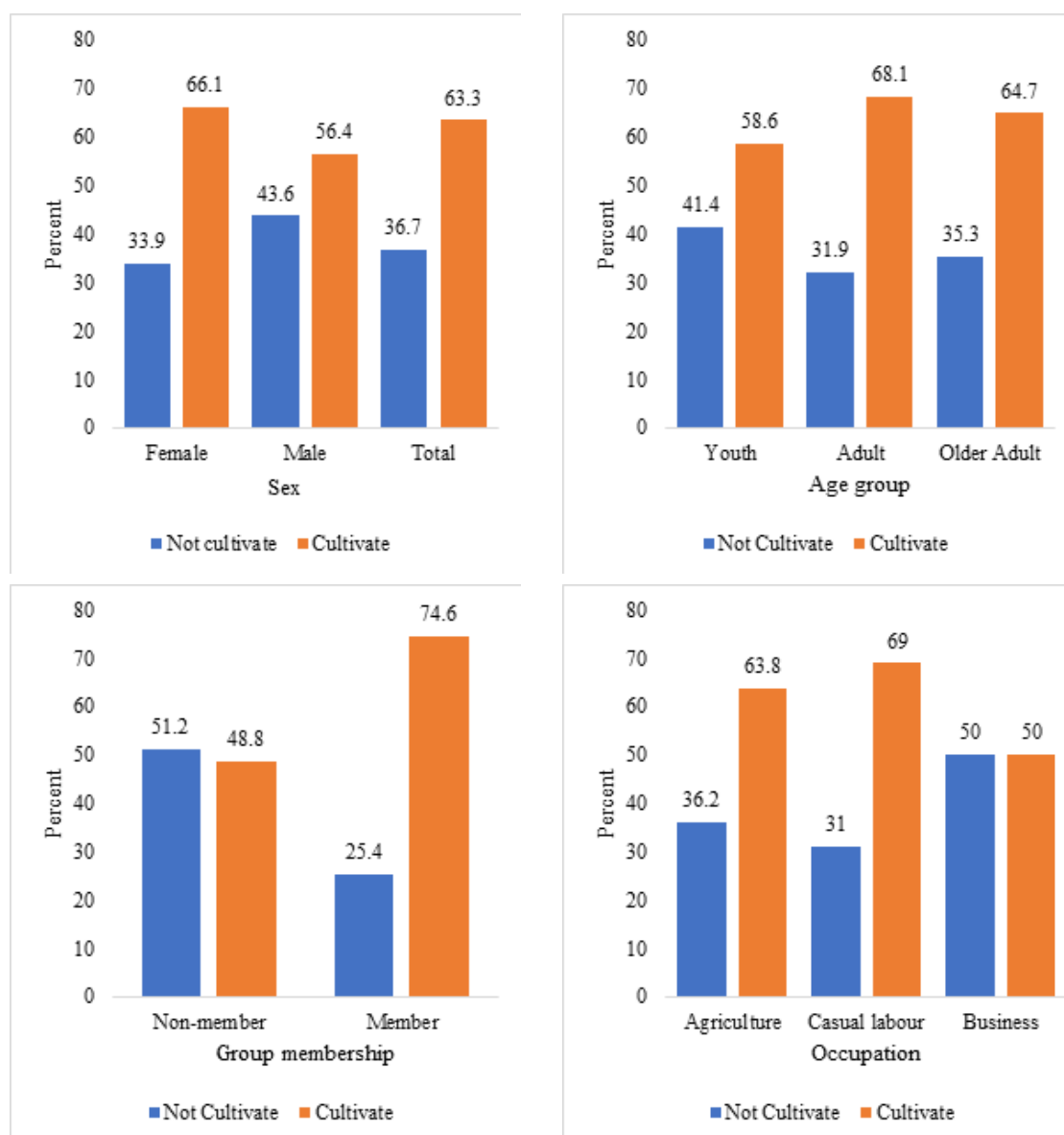


Figure 4. Household engagement in the cultivation of *Bidens pilosa* for economic purposes, categorized by (A) sex, (B) age group, (C) group membership, and (D) occupation

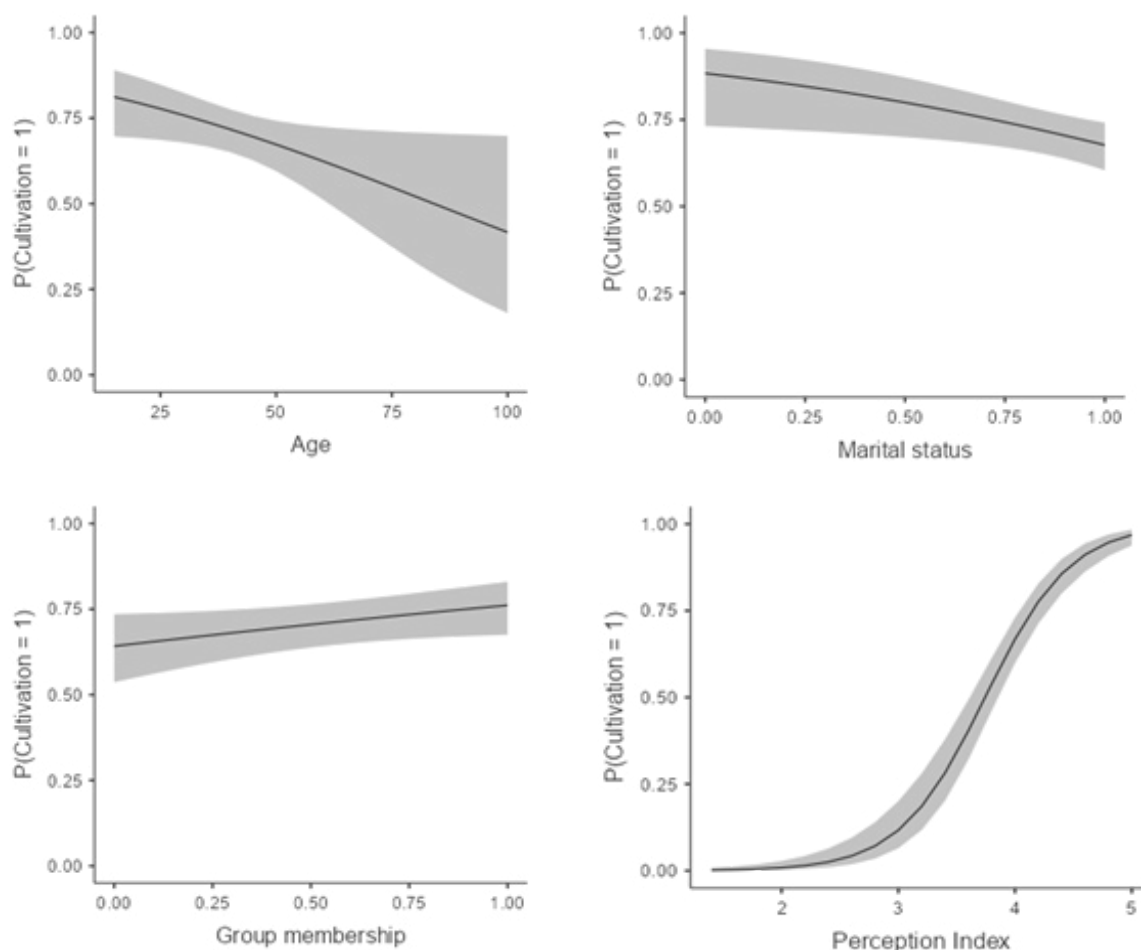


Figure 5. Estimated marginal probabilities of *Bidens pilosa* cultivation as influenced by (A) age, (B) marital status, (C) group membership, and (D) perception index. The plots illustrate declining likelihood of cultivation with age and significantly increasing probability with higher perception levels

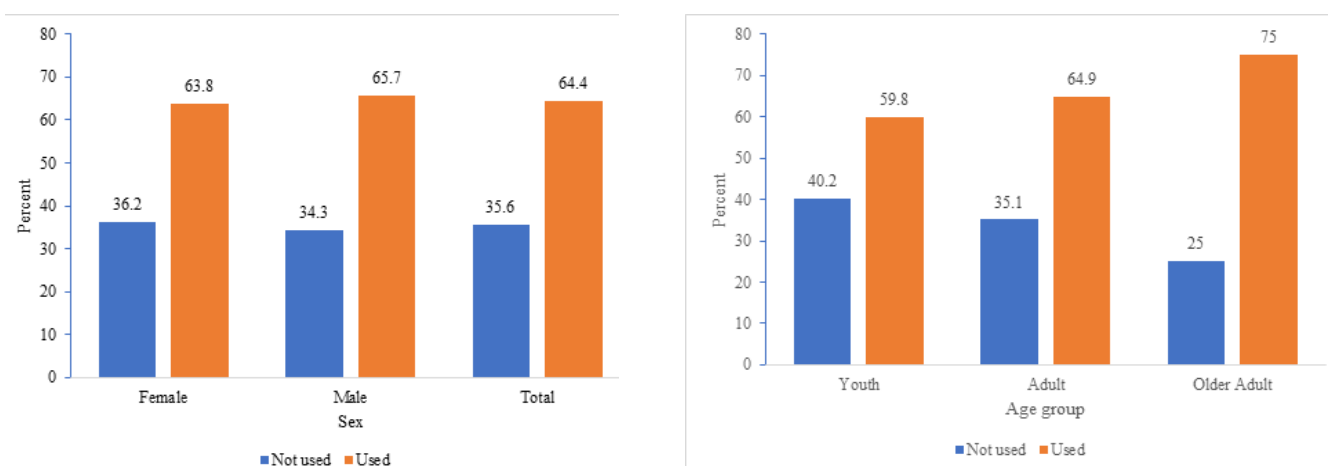


Figure 6. Proportion of respondents reporting cultural and spiritual use of *Bidens pilosa*, disaggregated by (A) sex and (B) age group

The crushed leaves are also used to cure skin infections by applying in the affected areas. In the treatment of ‘*manka*’, *Bidens pilosa* leaves are pounded and put them in under wear in women’s private parts. “We crushed together and the mixture is applied to a woman’s private parts, to treat “*manka*” (vaginal candidiasis) and “*masungu*”, the FGD participants narrated.

The study findings reveal the community members use *Bidens pilosa* to regulate blood sugar levels for individual suffering diabetes. The fresh *Bidens pilosa* leaves are boiled for few minutes, and its water is given to the patients having the sugar disease to drink. Further, boiled *Bidens pilosa* leaves are used to individuals suffering from asthma.

The patients are told to absorb the temperature coming from boiled fresh leaves by covering themselves in the pot containing the leaves.

The respondents also narrated that they use *Bidens pilosa* to treat coccidiosis diseases in chickens. “We simply get the whole plant of *Bidens pilosa* in chicken coops, and it feeds on leaves, buds, and soft stems”, one of the FGD participants narrated. One of the FGD participants reported that *Bidens pilosa* is used to make easy chemical which they used to blacken the hair.

The use of *Bidens pilosa* in traditional medicine is well-received, with community members returning to express gratitude. “Yes, and they come back to thank me after being healed by

the medicine prepared by me”, one of the participants narrated.

The economic role of *Bidens pilosa* in household livelihoods

Households demonstrate substantial involvement in the cultivation of *Bidens pilosa* for income, with 63.3% reporting engagement in cultivation compared to 36.7% not participating. Demographic participation differs, women exhibit greater cultivation rates (66.1%) compared to men (56.4%). In terms age group, adults demonstrate the highest rates (68.1%), followed by older adults (64.7%) and youth (58.6%). The significance of economic organization is evident, as members of farmer groups or associations exhibit a cultivation rate of 74.6%, compared to 48.8% among non-members. Households primarily engaged in casual labour (69.0%) and agriculture (63.8%) exhibit higher levels of cultivation compared to those involved in business (50.0%).

The logistic regression model (Table 2) indicates that marital status is significantly associated with lower odds of cultivating *Bidens pilosa* for economic purposes ($\beta = -1.2875$; OR = 0.276; $p = .018$). This suggests that married households have lower odds of cultivation compared to non-married households. Age demonstrates a modest yet significant negative correlation ($\beta = -0.0212$; OR = 0.979; $p = .037$), indicating that each additional year of age decreases the odds of cultivation. The perception index serves as the primary positive predictor ($\beta = 2.7250$; OR = 15.257; $p < .001$), indicating that a one-unit increase in perception increases the odds of cultivation by approximately 15 times.

From the qualitative study, the findings show that *Bidens pilosa* is a valuable economic asset, sold in markets and contributing to household income. The respondents reported that they sell fresh leaves in the markets. Further, they reported that the dry *Bidens pilosa* leaves for future use. Some of the community members dry *Bidens pilosa* leaves package them as leaf bags. Its preservation enhances market value. One of the participants revealed that “preserved one is expensive because it comes when there is scarcity on the market”. Another responded added by narrating that “we boil *Bidens pilosa* and extend it on the mat for it to dry and then preserve in leaf bags for presentation. Even someone is wounded when powder the same and apply on a wound because its already dry”. The powered *Bidens pilosa* is also used to treat wounds. The findings show that preserving the *Bidens pilosa* is hindered by environmental factors like moisture and pests. “The house should not be leaking because when *Bidens pilosa* has contact with water it develops molds (fungus) and rot. It is prone to entry of lizards which in turn soil the plant.”

Cultural and spiritual practices associated with the use of *Bidens pilosa* within local communities

Households indicate that *Bidens pilosa* is commonly associated with traditional healing, cultural, and spiritual practices, with 64.4% reporting such usage overall. The proportion of reported use is marginally greater among men (65.7%) compared to women (63.8%). Reported usage varies by age group, with 59.8% among youth, 64.9% among adults, and 75.0% among older adults. The results indicate a predominant acknowledgment of cultural and spiritual applications within the population, exhibiting a slight male–female disparity and a significant age gradient that favours older adults.

From the qualitative study, the study findings showed that *Bidens pilosa* plays a central role in marital fidelity, sexual strength, and traditional practices involving protection or

harm. On one hand, it was revealed that women use *Bidens pilosa* to hold their husbands so that the husbands should not be involved in marital relationship with other women other than the woman he married. “We burn the *Bidens pilosa* seeds and grind them forming black substance and add it to his food then he becomes attached to his wife no need for other women”, one of women in FDG narrated. “We use *Bidens pilosa* leaves are mixed with the leaves of a plant called ‘Poloni’, and the mixture is applied to a woman’s private parts, for our husbands not to have sex with other women”, another woman revealed in another FDG. “We take *Bidens pilosa* are combined with those of a plant known as ‘Poloni’ and the resulting mixture is applied to a woman’s intimate areas. It helps for sexual enjoyment too and husbands do not go to other women”, another woman concurred.

On the other hand, other community members revealed that they use *Bidens pilosa* for men to have strong intimacy in bedroom with their wives. “We, men, use *Bidens pilosa* for us to get energy. We mix and cook together. To gain the energy as I earlier alluded to, it should not be over cooked, we just boil a little bit for the person to be energetic and to aid the blood for the body to be energetic and work well in the bedroom”, one man in the FDG narrated.

Further, the participants reported that *Bidens pilosa* is used to kill a person by sending a lightening. “We smoke dried *Bidens pilosa* roots and leaves, mention the person as you breathe out, and lightning will strike the person”, the herbalist revealed. “*Bidens pilosa* is used to bewitch people by making them blind. In this case, a person specifically a student is bewitched, and he fails to study at school because his eyes are filled with darkness.” The herbalist continued as follow:

“*Bidens pilosa* is mixed with another plant which looks like ‘therere’ (okra) plant, then the mixture is rolled together like a cigar. After that, we lit the rolled mixture with fire and start smoking. Finally release the smoke into the air and mention what we want to happen to the victim. For instance, we can mention that ‘this one (name of a student) should not be able to read the question paper during examination. And it happens like that. As a result, the student cannot be able to read and write during examination. But when he is not in an examination room, he can read and write.’”

Discussion

This study’s findings indicate that *Bidens pilosa* is integral to household nutrition and traditional healthcare systems in Lilongwe District, Malawi, highlighting its significance as a multifunctional indigenous plant in local food and health systems. The high proportion of respondents reporting medicinal use, coupled with significantly higher perception scores among users, indicates that *Bidens pilosa* is actively integrated into daily household practices rather than being a marginal or emergency resource. Similar patterns have been reported across Sub-Saharan Africa, where indigenous leafy vegetables contribute simultaneously to nutrition and primary healthcare, particularly among rural and low-income populations^{5,24,30}.

From a nutritional standpoint, the incorporation of *Bidens pilosa* as a leafy vegetable is consistent with existing evidence indicating that indigenous leafy vegetables are abundant in essential micronutrients and dietary fibre. *Bidens pilosa* possesses significant amounts of vitamins, iron, calcium, and bioactive compounds, positioning it as nutritionally comparable to well-known exotic vegetables^{16,37}. The positive perceptions noted among users in this study indicate that households acknowledge the nutritional benefits through personal experience, supporting the assertion that indigenous

vegetables are essential in mitigating micronutrient deficiencies and dietary monotony in rural African diets.

The extensive medicinal application of *Bidens pilosa* identified in this study is well substantiated by ethnopharmacological literature. Extensive studies have established its antimicrobial, anti-inflammatory, antioxidant, and antidiabetic properties, supporting its traditional application in the treatment of gastrointestinal disorders, infections, wounds, and chronic diseases^{4,14,39,40}. Recent pharmacological reviews emphasize the immunomodulatory and therapeutic potential of *Bidens pilosa*, thereby reinforcing the biological foundation of its medicinal use^{2,36}.

The notable disparity in perception scores between users and non-users (Table 1) suggests that experiential use enhances confidence in the nutritional and medicinal value of the plant. The frequent household use of medicinal plants enhances perceived effectiveness and maintains reliance on traditional remedies, especially in situations where access to biomedical healthcare is restricted. The increased usage reported by older respondents underscores the influence of age and experience in maintaining traditional health practices, a trend commonly noted in ethnobotanical studies throughout southern and eastern Africa²⁶.

Our findings highlight the significance of recognizing *Bidens pilosa* as a functional food that contributes to nutrition and disease management. The alignment of household practices with scientific validation of bioactive properties offers opportunities for integrating indigenous vegetables into nutrition education, community health strategies, and sustainable food system policies. Promoting *Bidens pilosa* via culturally appropriate interventions could improve dietary diversity and reinforce locally accepted healthcare practices, in accordance with broader efforts to valorize underutilized plant species within African food systems³².

The present study results indicate that *Bidens pilosa* has a significant economic impact on households, especially through its cultivation for income generation. The variation in cultivation practices based on sex, age group, group membership, and occupation suggests that the use of *Bidens pilosa* as an economic resource is influenced by socio-economic and institutional factors, rather than being uniformly adopted by the entire population. This implies that economic use of indigenous and underutilized plant species is frequently affected by access to social networks, availability of labour, and livelihood orientation. African leafy vegetables (ALVs), which include *Bidens pilosa*, are recognized for their nutritional richness and adaptability, yet their full economic value remains underexploited due to poorly developed value chains and limited formal market integration.

The increased engagement in cultivation reported by males and those involved in agriculture illustrates the gendered and occupational patterns typically seen in smallholder farming systems in Sub-Saharan Africa. Men are more inclined to participate in the market-oriented cultivation of indigenous vegetables, whereas women typically take the lead in household-level consumption and processing⁴². This allocation of roles may partially elucidate why the economic cultivation of *Bidens pilosa* continues to be selective, despite its extensive availability and utilization.

Age-related variations in cultivation indicate that economically productive involvement with *Bidens pilosa* is primarily found among middle-aged and older adults, who generally have more farming experience, access to land, and

decision-making power. This may imply that older farmers are more inclined to experiment with or adopt underutilized crops for income generation, attributed to their accumulated knowledge and reduced risk aversion. This study's economic engagement demonstrates wider discussions regarding the unexploited commercialization potential of indigenous leafy vegetables. Reviews consistently indicate that species like *Bidens pilosa* exhibit advantageous agronomic traits, including low input requirements, adaptability to marginal conditions, and rapid growth, rendering them suitable for commercialization by smallholders³⁷. Weak value chains limited formal recognition, and the stigma surrounding "weedy" species persistently hinder their economic growth.

The findings have significant implications for livelihood diversification and rural development. Evidence indicates that *Bidens pilosa* may enhance household income, especially when cultivation is facilitated by collective organization and agricultural involvement. Enhancing the economic viability of *Bidens pilosa* can be achieved through promotion of small-scale value addition, and the integration of indigenous vegetables into extension and agribusiness programs. These strategies are increasingly acknowledged as means to enhance resilience and income security for smallholder farmers in Sub-Saharan Africa^{13,32}.

The cultivation of *Bidens pilosa* in Malawi is largely small-scale, relying on low-input traditional farming systems. This aligns with regional evidence indicating that African leafy vegetables (ALVs) are typically grown under rain-fed conditions using indigenous agronomic knowledge, with minimal external inputs such as fertilizers or improved seed varieties⁷. In countries such as Zimbabwe and Benin, similar patterns have been reported, where farmers either cultivate *Bidens pilosa* deliberately in home gardens or allow it to grow semi-wild alongside staple crops, taking advantage of its resilience and short growth cycle²⁶.

The adaptability of *Bidens pilosa* to marginal environments makes it particularly suitable for climate-resilient agriculture. Studies reported that underutilized crops can sustain productivity under adverse climatic conditions, thereby reducing production risks for smallholder farmers^{1,28}. Despite these advantages, the absence of structured seed systems and agronomic guidelines limits large-scale production and consistency in supply.

The study findings reveal that *Bidens pilosa* is marketed primarily in fresh and dried forms within local markets, contributing to household income. This is consistent with evidence from Nigeria and Benin, where indigenous vegetables are sold in informal markets dominated by small-scale traders, often women, with limited access to storage, transportation, and formal pricing systems³¹. Across SSA, indigenous vegetables typically follow short value chains, characterized by direct farmer-to-consumer sales, limited aggregation and processing and lack of certification or quality control systems. Such constraints significantly reduce their commercial value and scalability. Weak postharvest handling and inadequate storage infrastructure further contribute to high losses and seasonal price fluctuations, limiting income stability for producers³⁷. However, the findings from this study indicate emerging value addition practices, such as drying and powdering *Bidens pilosa*, which extend shelf life and improve marketability.

Beyond fresh consumption, *Bidens pilosa* presents significant opportunities for commercialization in the herbal tea

and nutraceutical sectors. Phytochemical studies confirm that the plant contains bioactive compounds such as flavonoids and polyphenols with antioxidant and anti-inflammatory properties, making it suitable for functional food and medicinal product development^{14,36}. In Nigeria, pilot initiatives have explored the use of indigenous plants in herbal tea production and nutraceutical formulations, demonstrating growing consumer demand for plant-based health products³¹. Similarly, in Benin and Zimbabwe, small enterprises have begun processing indigenous leafy vegetables into powders, teas, and supplements, although production remains at a nascent stage due to regulatory and technological barriers. The integration of *Bidens pilosa* into formal value chains, through product standardization, branding, and certification, could significantly enhance its market value.

Furthermore, the present study results demonstrate that *Bidens pilosa* is integrated into cultural and spiritual practices among specific segments of the study population, with participation differing across age groups and social affiliations. This illustrates that in addition to its nutritional, medicinal, and economic roles, *Bidens pilosa* serves as a plant of cultural significance within local belief systems and traditional practices. Multifunctionality is acknowledged in ethnobotanical literature, where plants are valued for their material benefits as well as their symbolic, spiritual, and social significance.

The increased engagement in cultural and spiritual practices among older respondents noted in this study aligns with a pattern frequently documented throughout Sub-Saharan Africa, where traditional rituals and the use of spiritual plants are predominantly preserved by older generations. Ethnobotanical studies indicate a strong correlation between age and participation in cultural practices, attributed to accumulated experiential knowledge and a closer adherence to indigenous belief systems³⁰. This generational pattern suggests that the cultural and spiritual applications of *Bidens pilosa* may face erosion as younger generations increasingly embrace modern lifestyles and biomedical perspectives.

The continued cultural and spiritual utilization of *Bidens pilosa* indicates the broader African cosmologies that intertwine health, spirituality, and nature. Healing plants frequently embody spiritual symbolism and are incorporated into rituals designed for protection, cleansing, or the restoration of balance in individuals and communities. Ethnopharmacological studies indicate that species like *Bidens pilosa* are frequently utilized in rituals that address both physical and metaphysical ailments, thereby merging the medicinal and spiritual realms³⁶. Our findings have substantial implications for the preservation of cultural heritage and sustainable development. The acknowledgment of the cultural and spiritual aspects associated with *Bidens pilosa* utilization highlights the necessity for culturally sensitive strategies in the promotion of indigenous plants for nutritional or economic purposes. Development interventions that overlook spiritual significance may jeopardize local acceptance and the sustainability of outcomes over time. Integrating cultural values into food system and biodiversity policies enhances community ownership and conservation of indigenous plant resources.

This paper adds to existing literature by presenting household-level data on the multifunctional applications of *Bidens pilosa*, thereby advancing beyond the primarily descriptive

or laboratory-centric approaches of previous studies. This study addresses a significant gap in ethnobotanical and food systems research by focusing on actual practices rather than solely on knowledge. The Quadri-Power Framework presents an innovative and comprehensive method for analyzing the ways in which indigenous plants contribute to nutrition, health, livelihoods, and cultural-spiritual well-being concurrently. The application of logistic regression model to determine socio-demographic and institutional predictors of economic and cultural engagement enhances methodological depth and empirical rigor.

The study offers policy-relevant insights regarding the significance of indigenous plants as strategic assets for sustainable development in sub-Saharan Africa. The findings indicate that *Bidens pilosa*, commonly classified as a weed, plays a significant role in household nutrition, traditional healthcare, income generation, and cultural identity. This evidence supports the incorporation of indigenous plant species into strategies for food security, climate-resilient agriculture, and livelihood diversification initiatives. The study emphasizes the significance of community organization and social networks, outlining practical strategies for enhancing the advantages of indigenous plants, thus fostering more inclusive, resilient, and culturally relevant development methods throughout Sub-Saharan Africa.

Conclusion and Policy Implications

This study demonstrates that *Bidens pilosa* is a multifunctional indigenous plant that plays a significant role in enhancing household nutrition, supporting traditional healthcare systems, contributing to rural livelihoods, and reinforcing cultural identity in Malawi. By applying the Quadri-Power Framework, the study provides integrated empirical evidence that this species operates across interconnected domains of food systems, health, economy, and socio-cultural practices.

In the context of nutrition and food security policies, including Malawi's National Multi-Sector Nutrition Policy, the findings highlight the potential of *Bidens pilosa* as a nutrient-dense indigenous vegetable capable of addressing micronutrient deficiencies and dietary diversity challenges. Its widespread use at household level suggests that policy interventions can build on existing local knowledge and practices, rather than introducing external solutions. Integrating indigenous vegetables such as *Bidens pilosa* into school feeding programs, community nutrition education, and extension services could significantly contribute to improved nutritional outcomes.

The study also aligns with Malawi's health policy priorities, particularly in primary healthcare and community-based health systems. The extensive use of *Bidens pilosa* for treating common ailments underscores its role as an accessible and affordable complementary healthcare resource. Formal recognition and validation of such medicinal plants, supported by phytochemical and pharmacological research, could enhance their safe inclusion within public health strategies, especially in rural areas with limited access to formal healthcare services.

Economically, the findings indicate that *Bidens pilosa* has untapped potential for value addition, market development, and agribusiness integration, consistent with Malawi's broader rural development and poverty reduction strategies. The promotion of small-scale processing (dried products, herbal teas, and nutraceuticals), coupled with improved market access and value chain development, could transform

the plant from a subsistence resource into a commercial commodity. Supporting farmer organizations, improving postharvest handling, and facilitating market linkages are critical policy entry points.

Importantly, the cultural–spiritual dimension of *Bidens pilosa* use highlights the need for culturally sensitive development approaches. Policies that recognize and integrate indigenous knowledge systems are more likely to achieve community acceptance and long-term sustainability. Ignoring these dimensions risks undermining adoption and weakening the relevance of interventions.

This study demonstrates that indigenous plants such as *Bidens pilosa* should not be viewed as marginal or secondary resources, but rather as strategic assets for achieving sustainable development goals in Malawi. Their integration into agricultural, nutrition, health, and economic policies offers a pathway toward more resilient, inclusive, and locally grounded development strategies.

Declarations

Ethical statement: The study protocol was approved by Mzuzu University Research Ethical Committee (MZUNIREC/DOR/24/107). The study adhered to the principles outlined in the Declaration of Helsinki.

Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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