Heliyon 9 (2023) e12978

Contents lists available at ScienceDirect

Heliyon

journal homepage: www.cell.com/heliyon

Research article

Indigenous agricultural knowledge: A neglected human based resource for sustainable crop protection and production

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ARTICLE INFO

Keywords:
Agriculture
Local agronomic practices
Pest-disease management
Farmers knowledge management

ABSTRACT

Indigenous knowledge, developed over generations and owned by communities or individuals within a community, offers alternative strategies and perspectives on resource management and use. However, as emphasized in the contemporary agricultural history of Ethiopia, the most effective indigenous agricultural knowledge has not been well documented and some of them are replaced by modern techniques. This study was therefore conducted to assess and document community-based techniques to control pests and diseases and the practical implications of indigenous farming techniques. A focus group discussion, key informant interviews and semi-structured questionnaires were conducted with 150 farmers. The result showed that a substantial number (92%) of the farming community uses indigenous based plant protection measures. Indigenous farmers (92%) splash liquids made of cow urine to control the adverse effect of fungi. Farmers are also using different seed selection methods for next season planting. About 29% of the farmers do single head-based seed selection prior to mass harvesting, 34% are collected as "*Qerm*" and 45% select their seeds during threshing. Indigenous farming knowledge varies with the natural feature of the growing location and cropping system, including the rainfall pattern, soil fertility status, crop, and weed type. The observed positive effect of indigenous agricultural practices on crop production substantiates the need to include these essential approaches in the cultivation system along with the modern agronomic techniques. This might reduce the dependency on expensive and pollutant agricultural inputs. However, sociodemographic factors such as educational level, marital status and farming experience have been found as a determinant factor that influences utilization of indigenous farming knowledge. It can be therefore inferred that documenting indigenous knowledge and proving its applicability scientifically could contribute to organically oriented agricultural production and consequently reduce agriculture's contribution to environmental pollution.

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https://doi.org/10.1016/j.heliyon.2023.e12978
Received 5 April 2022; Received in revised form 31 December 2022; Accepted 10 January 2023
Available online 14 January 2023

1. Introduction

Ethnopedology became an important research approach centered on formalizing local indigenous knowledge into classification schemes and assessing agro-ecological management practices [1]. This approach is a hybrid discipline structured from the combination of natural and social sciences with a primary aim of documentation and improving understanding of the local indigenous knowledge for endogenous sustainable development [2]. Indigenous agricultural knowledge (IAK) has always been an essential power for agricultural development. It is a systematic and collective body of knowledge, practice, and belief that is developing through adaptation processes and cascading through generations by cultural transmission about the relationship of living beings with their environment [3,4]. With this collective knowledge, farmers have been producing food crops in divergent environmental conditions and seasonal variability without access to external inputs, resources, and scientific knowledge [5]. This could further refrain farmers from using synthetic agrochemicals rather promote indigenous techniques such as crop rotations and soil fertility restoration through closed nutrient cycles [6].

Agronomic practices such as inter-cropping, terracing, mixed cropping with legumes to increase reliance on biological fertility, and adaptation of agroforestry are among the indigenous farm practices used [6,7]. These could substantially reduce environmental pollution because reducing the use of modern agricultural inputs such as chemical fertilizers, insecticides and herbicides might reduce carbon, nitrogen, and water footprints, and could serve as a mitigation option for greenhouse gas (GHG) emissions [8]. Thus, fostering indigenous technologies and knowledge in modern agriculture through the intensification of interaction among local networks and organizational arrangements could be very important [9].

As an agrarian community, Ethiopian farmers also use a number of indigenous agricultural practices as adaptation and mitigation strategies for the changing climate and to reverse the adverse effect of pests and diseases [10,11]. However, due to modern-day technological advancement, indigenous agricultural knowledge has been gradually neglected and disregarded on the pretext of being not-scientifically based [12]. This attempt causes an enormous decline in using indigenous knowledge and has made an enormous replacement as well by the contemporary agricultural techniques [13,14]. These situations are partly due to some barriers to the successful acquisition of indigenous agricultural knowledge such as failure to recognition of IAR, improper documentation and communication of IAK, which have been leading to intergenerational information gaps [10,13].

The undermining of indigenous farming knowledge within the community could constitute an enormous loss to humanity, as they possess the potential remedy to a number of bottlenecks that have been emasculated by development strategies for several decades. Even though the local indigenous farming knowledge may be fated to decline and even disappear over time, this indigenous knowledge could be acquired and documented, aimed at filling the intergenerational information gap and the resilience of future agriculture. Using community-based and collectively held IAK could offer valuable insights, complementing scientific data with chronological and site-specific precision that could bring a universal change in agricultural productivity. Nevertheless, the responsible actors such as offices of agriculture do not frame the priorities for documentation of IAK in the study areas, as it does elsewhere in other parts of the world. These clearly indicated that works should be done to document and inform young generations on the importance of IAK parallel to the modern agricultural knowledge. This should not be simply as part of the historical knowledge archive, but to ensure proper utilization and attribution of it now requires the documentation of such knowledge as a contemporary form.

In general, documentation of IAK might give focus on creating, capturing, preserving, and sharing commence to show the importance of the management of agricultural indigenous knowledge, particularly in developing countries [15]. Assessing and

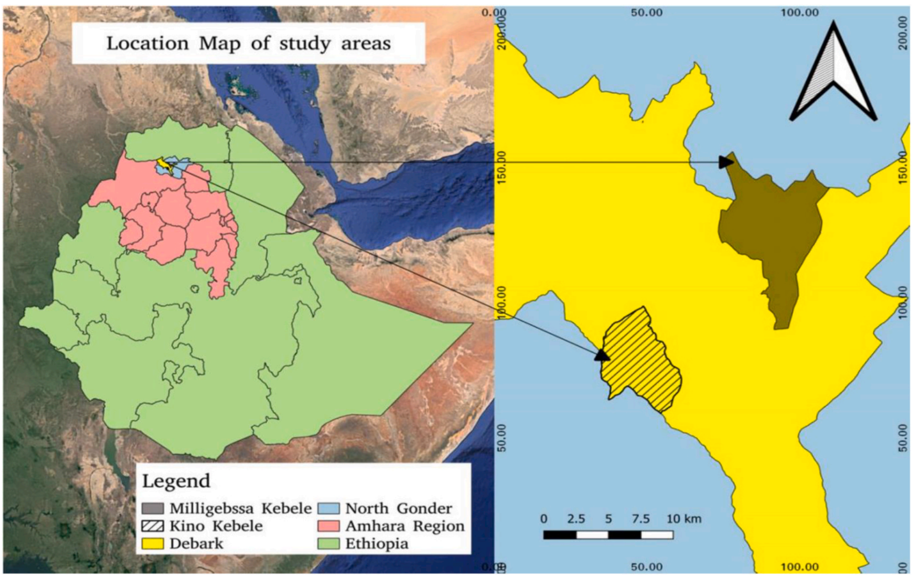

Fig. 1. Location map of the study areas.

documenting the farmer's indigenous based knowledge and their experiences to manage weeds, diseases and pests could have a double benefit. The first is cost reduction while the second is environmental and societal health. The current study was initiated to document farmers' traditional agronomic practices used to protect their crop plants against pests and diseases, with specific emphasis given to farmers in North Gonder, Ethiopia.

2. Material and methods

2.1. Description of the study area

The assessment was conducted at two villages (*Kino and Milligebsa*) of Debark district, North Gondar administrative zone (Fig. 1). This district (Debark) is located north of Addis Ababa at 850 km distance. Geographically, the first site, Kino, is located at 13°4′51″-13°4′52″ N latitude and 37° 53′17″-37° 53′19″E longitude at an elevation of 2717 m above sea level (m.a.s.l), while the second site, Milligebsa, is located at 13°11′41'' - 13°11′42″N latitude and 37° 59′2″- 37° 59′3″E and at an elevation of 3153 m. a.s.l. This site lies in the highland part of the Amhara regional state with an average annual rainfall of 974 mm and an average annual temperature of 12.4 °C. The farming activity is subsistence mixed farming where crop and animal production dominates the system [16].

The study sites are characterized by erratic rainfall distribution. The main rainy season is from June to September with the maximum rain, about 70–80%, received in July and August months. Major crops grown in the study areas include barley (*Hordeum vulgare*), wheat (*Triticum* spp.), faba bean (*Vicia faba*), field pea (*Pisum sativum*), and flax (*Linum usitatissimum*). Home garden crops include vegetables like potatoes (*Solanum tuberosum*), garlic (*Allium sativum*), and leafy greens. Cattle, horses, donkeys, mules, sheep, goats, chickens, and bees are major parts of the farming system [16].

2.2. Data collection and management

Study participants were systematically sampled from the two villages based on their age, gender, educational status, farming experience, and IAK of local practices. As data collection tools, questionnaires, key informants and focus group discussions were used consistently in both villages. A semi-structured questionnaire comprising about 20 closed questions, some of them with open-ended part were conducted involving 150 participant farmers, 75 from each study site to understand the extent of application and use of IAK in pest and disease management. To substantiate the findings of the household interviews, six focus group discussions, each consisting of 12 participants, were carried out involving participant farmers from the two sites. The focus group discussion participant farmers were disaggregated by age (22–75 years) as age is an important variable associated with knowledge documentation and gathering in-depth information (Table 1). Data was collected on the IAK of weed, pests, and disease management, benefits generated and sources of organic manure. The interviews and FGDs were conducted in local language “Amharic” as participant farmers do not either understand or speak English. The collected information by the rapporteurs was translated into English before embarking on data analysis.

2.3. Statistical data analysis

After checking for normality and homogeneity, cleaned raw data were subjected to statistical analysis using the SPSS statistical software (vr.25) to generate descriptive statistics such as means, frequencies, and proportions. Chi-square (X^2) tests were used to assess the relationship between sociodemographic factors, and farmers indigenous knowledge. In multivariate analysis, a binary logistic regression model was done to identify factors associated with IAK using the crude odd ratio (COR) and adjusted odd ratio (AOD). These ratios were calculated to assess the strength of the association between IAK and explanatory variables. The binary logistic regression model was used because there were only two possible outcomes (i.e. yes/no), whereas one specific outcome was selected as a reference. The significance of statistical associations was assured using odds ratios at 95% confidence interval (CI) and *p-values*.

Table 1
Sociodemographic characteristics of the stakeholders (age, gender, and level of education; N = 150).

Characteristics	Frequency	Percent (%)
Age		
20-39	15	10
40-50	65	43
51-75	70	47
Total	150	100
Gender		
Male	142	96
Female	8	5
Total	150	100
Level of education		
Illiterate	48	32
Informal	65	43
Formal primary school	37	25
Total	150	100

Statistical significance was accepted at the 5% level. Analysis results were presented in Tabular and figurative forms where the mean values of frequencies were used to construct the graphs using excel graphing features.

3. Results and discussion

3.1. Sociodemographic characteristics

Among the total 150 study participant farmers of the two villages, the majority (95%) were males aged 51–75 years old (Table 1). Age is associated with IAK and including elderly farmers is believed to benefit in knowledge sharing to younger farmers. Education is also a key factor for uptaking modern agricultural technologies. Among the participants, about 42% of them have primary education with reading and writing skills. Literatures showed that education is an essential human capital that can improve ability of the farmers to perceive, absorb, and implement innovations in the farm, hence, education level could positively or negatively impact the adoption and management of agricultural indigenous knowledge within the farming community.

3.2. Indigenous knowledge for crop protection

The traditional way of pest and disease management practices have been developed over generations and used by local farmers for centuries even before the use of modern pesticides. Farmers in different parts of Ethiopia have been using different traditional methods to protect crops from pests and diseases in the field as well as in storage. Some of the major methods and associated indigenous knowledge were presented below.

3.2.1. Animal urine

From study participant farmers, quite many (92%) of them are using traditional methods and knowledge to protect their crops from pests and diseases (Table 2). These indigenous plant protection measures comprise a wide range of non-chemical options employed by indigenous farmers for cereal and legume crops. Of the surveyed farmers, 89% of them reported the use of cow urine to protect seedlings of some crops from pests and diseases (Table 2). Seeds or life plant is treated by cow urine to eliminate or reduce the adverse effect of fungi and some insects such as earthworms at early to developmental stages Scientific investigations indicated that cow urine has an anti-fungal activity that suppresses the effect of fungi and bacterial diseases [17,18]. Such seed treatment improves germination and protects seedlings from failure. Cow urine is confirmed to contain antifungal chemicals like phenolic acids (i.e. gallic, caffeic, ferulic, *o*-coumaric, cinnamic, and salicylic acids) [19]. Farmers in Gonder, Ethiopia, apply cow urine using their innate indigenous knowledge for centuries to protect their crops against pests and diseases. It is easily accessible and affordable to them as they practice a mixed farming system where livestock is strongly integrated into crop production.

Furthermore, the use of cow urine is environmentally friendly as it is an organic approach. It has been proved that the application of cow urine also improves soil nitrogen content and hence improves soil fertility level [20]. The use of cow urine instead of chemical fungicides by farmers in the study area reduces their cost of production and is in line with the green development policy of Ethiopia due to its positive environmental benefit. The study and documentation of such indigenous knowledge-based crop protection methods are important to replicate the methods as a response to the call to environmental health. About 7% of participants farmers were aware of the use of integrated pest management (IPM) where they apply cow urine and fungicides at different developmental stages of the crops in case the disease occurrence is severe. About 3% of them have reported a dependency on pesticide application to control pests and diseases. The findings suggest that the majority of farmers in north Gonder control pests and diseases organically.

3.2.2. Physical barriers for rodents' protection

Participant farmers have identified rodents as major field and storage pests causing significant crop damage. Study farmers have indicated that they have been using some traditional methods to protect these rodents. Tunneling and burrow digging were mentioned as physical barriers used to protect rodents such as rats (Table 2). This method for rodent control was mentioned by 7% of the stakeholders of the study. The prepared tunnel is filled with cow dung solution to serve as a trap for the rodents as they enter the tunnel

Table 2
The use of cow urine to reduce the effect of seed borne fungi.

Animal urine	Respondent number	Percentage (%) of stakeholders
Non-users	15	9
Users	135	91
Total	150	100
Disease and pest control me methods		
Animal urine	133	73
Integrated use of pesticide and animal urine	12	7
Pesticide	5	3
Physical barriers (rodents)	30	17
Total*	180	**100**

NB: *The total number of stakeholders in this particular case exceeded 150 because single participant could have mentioned more than one control methods.

to cross to the storage structure or crop field. The effectiveness of tunneling and burrow digging as rodent control methods was reported by Refs. [11,21]. Participants indicated that post-harvest yield loss because of rodents is, however, lower compared to that caused by fungal diseases in most crops. However, huge post-harvest yield loss is usually recorded in plots adjacent to forest lands [21]. For field rodents, the construction period of physical barriers is crop developmental stages specific. Farmers know that rodents use crop fields as habitat as well and high populations of these rodents are recorded from vegetative to maturity developmental stages, thus physical barriers are placed during these stages [21,22]. Their IAK of synchronizing protection measures to crop developmental stages is much appreciated and was found to be scientific. Placing physical barriers around the field or storage structures is effective to control rodents that appear both during day and night times. Some rodents are passive during the day but become active during the night times and are difficult to control with other control methods other than such physical barriers. Despite being labor intensive and skill demanding methods, the use of physical barrier is an ecologically based practice that reduces the dependence on rodenticides and hence improves environmental health.

3.2.3. Traditional slings and drumming

During consensus discussions with participant farmers, it came out that birds are the major vertebrate pests causing tremendous damage to cereal crops, particularly at physical maturity developmental stages. Almost all FGD participant farmers reported this pest commonly affects their crop production. The common protection method widely used is scaring them through scary sounds and traditional sling weapons locally called "*Wenich'ifi*" (Fig. 2). The sounds/noises created by these weapons are uncomforting to the birds and reduce the damage A sling is like a weapon that comprises of a looped strap where a stone is put in it and the sling rotated over the head to fire the stone to heat the birds at distance.

This approach might be the best indigenous bird repellent in the organic farming system and more productive if it would be combined with other modern alternatives. A similar practice has been reported by Ref. [24].

3.3. IK on seed selection

Until recently Ethiopian farmers depend on their own saved seeds for planting for many years even now for most crops. Seeds are saved either from single head selection or bulk harvest. Farmers have developed knowledge over generations on plant selection for seeds and these plants are sampled during different production periods (Table 3). Farmers select the best plant/spike/head/cob, according to the crop type, prior to mass harvest and bulk the selected plants for the next planting. About 19% of the participant farmers reported the use of before harvest plant selections for seed and save for next planting season. About 30% of the farmers collect their seed after the bulk harvest of the crop with some quality compromise. This is actually the common seed-saving practice in Ethiopia for the informal seed supply. Plants are sampled for seed even after harvest from plants that escaped from the farm either during harvesting or transporting. The escaped plants are called "Qerm" which is used as seed by about 23% of the participant farmers. The majority (32%) of the stakeholders have been sampling plants for seed saving from both fields through plants selection and bulk saving from harvested and threshed crops (Table 3). Sampling plants before harvesting is believed to sample quality seeds which are vigor, plumpy and disease free for next season planting. Belemie and Singh [25] confirmed that plant sampling for seeds and preserving seeds for next panting season is a common practice in many developing countries. This practice is also practiced in contemporary crop improvement programs [26]. These approaches of seed selection and saving for preceding year planting have different impacts on farm diversification, which help farmers to adapt well to the changing stressors.

3.3.1. Indigenous weed control methods

Weeds are an important factor in crop production and their control measures are critical to farmers' productivity and environmental health. Smallholder farmers have been using indigenous weed control practices to reduce the effect of weeds on crop

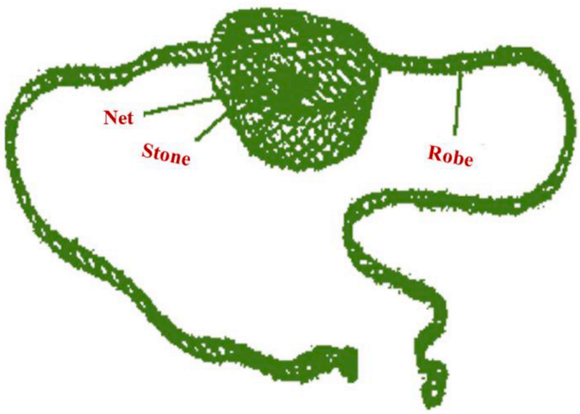

Fig. 2. Traditional slings employed by the local farmers for scaring birds in the field (adapted from FAO [23] for explanation only).

Table 3
Traditional ways of seed selection and saving methods in Gonder, Ethiopia.

S·N	Farmers seed selection method	Number of stakeholders	Percent (%) of stakeholders
1	From field	29	19
2	During threshing	45	30
3	From “Qerm”	34	23
4	From field and during threshing	48	32
	Total	**150**	**100**

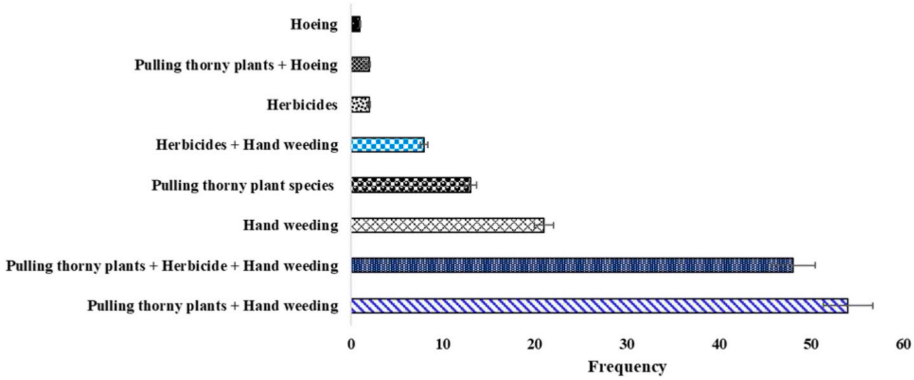

Fig. 3. Methods of indigenous weed control methods practiced by north Gonder farmers.

productivity. Our study identified some physical weed management methods such as hand weeding, superficial hoeing, frequent tillage, and pulling thorny plant species have been reported as indigenous weed control options (Fig. 3). The study showed that pulling thorny plant species in combination with hand weeding or herbicide application is the most common method of weed control. Hand weeding and pulling thorny plant species as a sole weed control method were assigned the next ranking (Fig. 3). Superficial hoeing is carried out after germination, which incorporates the weeds into the soil and this enhances nutrient recycling of the farm [27].

We have learned that farmers sometimes refuse weed management recommendations by extensions system for faba bean production. The extension recommends to key farms be free of weeds. However, complete removal of weeds from faba bean farms is not the intention of farmers, and crop development stages at which weed control applied matters. Most of the participant farmers believe that weed removal at later crop developmental stages has the power to reduce the chance of soil-borne diseases and help to reserve more weed biomass (Fig. 4). The reserved weed biomass in faba bean fields is used for livestock feed during the main cropping season, especially when stubble grazing is unavailable, and crop residue stocks are low to satisfy the feed demand. Although the farmers follow traditional weed management options, their traditional and indigenous weed management practices have been scientifically confirmed that the total metabolizable energy produced from the weed forage biomass could provide approximately 18 GJ h^{-1} [28]. This amount of energy would be enough to satisfy the feed requirements of five to six mature cattle for about three months [28].

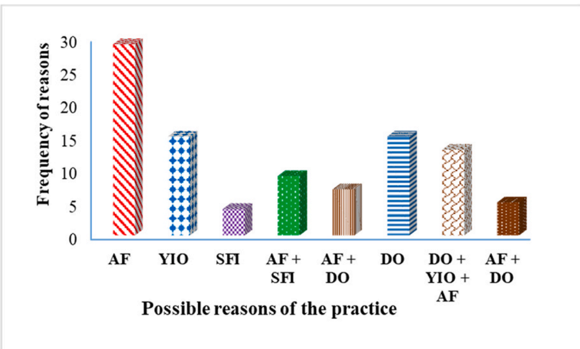

Fig. 4. Use of weeds removed from faba bean at later flowering stage of the crop. Key to abbreviations: **AF**, for animal fodder; **YIO**, as yield improvement options; **SFI**, as soil fertility improvement option; **AF + SFI**, for animal fodder and soil fertility improvement; AF + DO, for anima fodder and reduce likelihood of Diseases occurrence; **DO**, to reduce likelihood of disease occurrence.

Table 4
Effect of sociodemographic factors in the use of agricultural indigenous knowledge to improve agricultural productivity.

Variables	Predictor	Number of stakeholders (%)	IAK to improve farm productivity			
			No (%)	Yes (%)	Crude OR (95% CL)	Adjusted OR (95% CL)
Gender	Male	142 (95)	67 (97)	75 (93)	0.37 [0.07–1.91]	1.32 [0.14–12.55]
	Female	8 (5)	2 (3)	6 (7)	1 †	1
Age	20–39	15 (10)	10 (14)	5 (6)	0.42 [0.13–1.36]	0.67 [0.12–3.86]
	40–50	65 (43)	27 (39)	38 (47)	1.19 [0.60–2.34]	1.32 [0.53–3.29]
	51–75	70 (47)	32 (46)	38 (47)	1 †	1
Marital Status	Married	127 (85)	66 (96)	61 (75)	0.14 [0.04–0.49]	0.06 [0.01–0.37]
	Single	23 (15)	3 (4)	20 (27)	1	1
Education status	Illiterate	48 (32)	21 (30)	27 (33)	0.88 [0.37–2.09]	0.18 [0.05–0.70]
	Informal (read and write)	65 (43)	33 (47.8)	32 (40)	0.66 [0.29–1.50]	0.46 [0.18–1.19]
	Primary School	37 (25)	15 (22)	22 (27)	1	1
Farming experience (in year)	8–18	33 (22)	20 (29)	13 (16)	0.14 [0.03–0.78]	0.11 [0.01–1.13]
	19–29	91 (61)	39 (56)	52 (64)	0.30 [0.06–1.45]	0.29 [0.04–2.14]
	30–40	15 (10)	8 (12)	7 (9)	1.94 [0.03–1.22]	0.25 [0.03–2.09]
	41–50	11 (7)	2 (3)	9 (11)	1	1

NB: *$p < 0.05$, numbers enclosed in parentheses indicates percentage (%) and the square bracket [CL] indicates the confidence level; † represents the reference group.

4. Factors affecting the use of IAK

Although participant farmers have a wide range of IAK, these knowledges, however, been significantly *($p < 0.05$)* influenced by their level of education, farming experience and marital status (Table 4). Indeed, education is positively related to indigenous agricultural knowledge and perceived benefits as well. Farmers who acquired either formal or informal education to the level of reading and understanding technologies have acquired better IAK than the other groups (Table 4).

Furthermore, age differences in the community have been observed to affect IAK, where elderly people know more about IAK than young people (Table 4). The difference could be attributed to the accumulation of IAK over years and adapting it to the local growing conditions [29]. Besides like of long term experience, young farmers consider the IAK as backward practice compared to modern plant protection and production methods and this makes it difficult for the elders to transfer the knowledge to their descendants [30]. This has been triangulated in the focus group discussion, although farmers are still using their indigenous farming knowledge, the extent and use of IAK are declining from time to time due to a lack of interest among young farmers. This means that the strong social networks and associated functions in the past are becoming very weak, probably due to the individualistic nature of the current farming community, which was also a limitation of this study. Hence, there should be a forum where elders of the communities can meet to share and exchange their knowledge, experience, and expertise, particularly for the young farmers.

The analyzed odds ratio indicated that different predicators, such as gender, education status, age, and farming experience have influenced IAK in the study areas (Table 4). The Odds ratio values indicated that farmers with farming experience of less than 18 years were observed to have less influence on the decision of using IAK than farmers with more farming experience (Table 4). This indicates that the likelihood of accumulating and using IAK significantly increased with years of engaging in farming and associated activities. Similarly, the likelihood of married farmers influencing the use of IAK is significantly *($p < 0.05$)* higher than unmarried farmers. Badstue et al. [31] has been confirmed that single households are own experience and control over their production decision than married couples. This difference could be due to multiple family tasks and associated responsibilities of married households than single house headed farmers. Education level, age, and gender are also determinants of the use of IAK with different OR between the classes of each factor.

5. Conclusions

Indigenous agricultural knowledge is observed as an important national human capital to improve crop productivity and enhance sustainable agricultural development. Fostering and documentation of IAK can promote the wider use of organic crop production methods and sustain environmental health. Although indigenous knowledge about crop protection and yield improvement is widely practiced by the majority of the farming community, there are differences in wisdom among farmers according to age, gender, marital status and farming experience. There has been also an intergenerational gap in utilization of IAK, thus proper documentation of these IAKs and communication with young generations is very important. Proper documentation of IAK and archiving them is for two fundamental reasons (a) it could be used as a reference for the next generation (b) and it can create access for extension workers to coincide modern production and protection methods with IAK to minimize the impact of modern agriculture. The study, therefore, recommends the establishment of a center where local farmers' indigenous knowledge is systematically documented and kept, probably at the local, zonal or regional level. This could facilitate the possibility of applying such local indigenous agricultural knowledge and technology in harmony with the contemporary agricultural practices. Moreover, proving the potential of IAK through scientific investigations might also accelerate their inclusion in modern agricultural intervention measures.

Data availability

The data used to support the findings of this study are available from the corresponding author upon request.

Ethics statement

The studies involving human participants were reviewed and approved by the College of Agriculture and Environmental Science, and Office of Vice President for Research and Community Service, Debark University. Then, concerned officials of Debark district agricultural office were communicated through formal official letters written by Debark University. The district agricultural office has provided an official letter to local extension workers and agricultural agents of both selected villages. Before data collection, each participant was clearly informed about the objectives of the study and provided verbal consent. To ensure confidentiality of participants, anonymous coding was used whereby the name of the participants and any participants' identifier were not written on the survey note.

Author contribution statement

Melash A.A: Conceived and designed the experiments, Performed the experiments, Analyzed and interpreted the data and wrote the paper. **Dejene K.M:** Conceived and designed the experiments, wrote the paper, read and edit the manuscript. **Amare A.B.:** Conceived and designed the experiments, Performed the experiments. **Éva B.Á.:** analysis data, wrote the paper. **Gashaw G.C:** Performed the experiments; **Attila P.:** wrote the paper, read **Abeje T.M.:** Performed the experiments.

Declaration of competing interest

All the authors declares that there is no conflicts of interset.

Funding statement

The authors acknowledged the financial support provided by Debark University, Ethiopia, with a grant number DKU001/11.

Acknowledgements

We, the authors, are grateful for the farmers from the two communities for their interest to take part in the study and disclose their indigenous knowledge.

References

[1] N. Barrera-Bassols, J.A. Zinck, Ethnopedology: a worldwide view on the soil knowledge of local people, Geoderma 111 (3–4) (2003) 171–195, https://doi.org/10.1016/S0016-7061(02)00263-X.
[2] G.F. Capra, A. Ganga, A. Buondonno, E. Grilli, C. Gaviano, S. Vacca, Ethnopedology in the study of toponyms connected to the indigenous knowledge on soil resource, PLoS One 10 (3) (2015) e0120240, https://doi.org/10.1371/journal.pone.0120240.
[3] R.D. Tella, Towards promotion and dissemination of indigenous knowledge: a case of NIRD, Int. Inf. Libr. Rev. 39 (3–4) (2007) 185–193.
[4] O.C. Ajayi, P.L. Mafongoya, Indigenous Knowledge Systems and Climate Change Management in Africa, CTA, Wageningen, The Netherlands, 2017, p. 316.
[5] A. Maroyi, Enhancing food security through cultivation of traditional food crops in Nhema communal area, Midlands Province, Zimbabwe, Afr. J. Agric. Res. 7 (2012) 5412–5420.
[6] Y. Maru, A. Gebrekirstos, G. Haile, Farmers' indigenous knowledge of tree conservation and acidic soil amendments: the role of "baabbo" and "Mona" systems: lessons from Gedeo community, Southern Ethiopia, Cogent Food & Agric. 5 (1) (2019), 1645259, https://doi.org/10.1080/23311932.2019.1645259.
[7] J. Degaga, B. Angasu, Assessment of indigenous knowledge of smallholder farmers on intercropping practices in west Hararghe Zone; Oromia National Regional State, Ethiopia, J. Agric. Ext. Rural Dev. 3 (3) (2017) 270–278.
[8] N. Arunrat, S. Sereenonchai, W. Chaowiwat, C. Wang, R. Hatano, Carbon, nitrogen and water footprints of organic rice and conventional rice production over 4 Years of cultivation: a case study in the lower north of Thailand, Agronomy 12 (2) (2022) 380, https://doi.org/10.3390/agronomy12020380.
[9] L. Ha, R.N. Okigbo, P. Igboaka, Knowledge creation and dissemination in sub-Saharan Africa, Manag. Decis. 46 (3) (2008) 392–405.
[10] R. Mosissa, W. Jimma, R. Bekele, Knowledge management strategy for indigenous knowledge on land use and agricultural development in Western Ethiopia, Universal J. Agric. Res. 5 (1) (2017) 18–26, https://doi.org/10.13189/ujar, 050103.
[11] A. Mathewos, F. Gebeyehu, Assessment of indigenous knowledge used to control pests and to reduce risks of pesticides in wolaita and dawuro zones, J. Pharmacy Alt. Medicin 10 (2016) 46–53.
[12] H.O. Kaya, J.Z. Matowanyika, The value of african indigenous knowledge systems in community-based climate observation practices and synergies with climate information services in africa, in: WISER Knowledge Management and Communication Workshop, Addis Ababa, Ethiopia, 2017, May, pp. 24–26.
[13] M. Asmamaw, S.T. Mereta, A. Ambelu, The role of local knowledge in enhancing the resilience of dinki watershed social-ecological system, central highlands of Ethiopia, PLoS One 15 (9) (2020) e0238460, https://doi.org/10.1371/journal.pone.0238460.
[14] G. Yohannes, Conflicts of indigenous farming practices and modern agriculture in konso community, southern Ethiopia, J. Agric. Sci. Technol. 5 (2015) 589–600, https://doi.org/10.17265/2161-6264/2015.09.001.
[15] E.T. Lwoga, P. Ngulube, Managing Indigenous and Exogenous Knowledge through Information and Communication Technologies for Agricultural Development and Achievement of the UN Millennium Development Goals in Tanzania, 2008.
[16] B. Tefera, M.L. Ruelle, Z. Asfaw, B. Abraha Tsegay, Woody plant diversity in an Afromontane agricultural landscape (Debark District, northern Ethiopia), For. Trees Livelihoods 23 (4) (2014) 261–279, https://doi.org/10.1080/14728028.2014.942709.
[17] R. Rana, S. De, In vitro antimicrobial screening of cow urine-a potential natural antimicrobial agent, Int. J. Bioassays 2 (2) (2013) 436–439.
[18] H.R. Patil, H.K. Makari, H. Gurumurthy, S. Mukunda, T.P. Kekuda, D.M. Chetan, H.A. Kumar, Effect of cow urine on fungal spore germination, Biotechnology: An Indian J. 1 (3) (2007) 130–134.

[19] U.P. Singh, S. Maurya, A. Singh, G. Nath, M. Singh, Antimicrobial efficacy, disease inhibition and phenolic acid-inducing potential of chloroform fraction of cow urine, Arch. Phytopathol. Plant Protect. 45 (13) (2012) 1546–1557.
[20] T. Gotora, L. Masaka, M. Sungirai, Effect of cow urine on the growth characteristics of Fusarium lateritium, an important coffee fungus in Zimbabwe, Int. J. Agronomy 2014 (2014), 986068, https://doi.org/10.1155/2014/986068.
[21] B.T. Wondifraw, M.Y. Tamene, A.B. Simegn, Assessment of crop damage by rodent pests from experimental barley crop fields in Farta District, South Gondar, Ethiopia, PLoS One 16 (8) (2021) e0255372, https://doi.org/10.1371/journal.pone.0255372.
[22] Y. Meheretu, V. Sluydts, K. Welegerima, H. Bauer, M. Teferi, G. Yirga, L. Mulungu, M. Haile, J. Nyssen, J. Deckers, R. Makundi, Rodent abundance, stone bund density and its effects on crop damage in the Tigray highlands, Ethiopia, Crop Protect. 55 (2014) 61–67, https://doi.org/10.1016/j.cropro.2013.10.016.
[23] FAO, Indigenous Technology Knowledge for Watershed Management in Upper North-West Himalayas of India, 1998 (GCP/RAS/161/NET). Chapter-6 plant protection measures Accessed date December 10/2020. Available at: http://www.fao.org/3/x5672e/x5672e00.htm#Contents.
[24] M. James, P. Lahai, T. Gaskin, Slings and stones for birds. A factsheet for farmers, Published at Plantwise Factsheets Library. Accessed date December 8/2020. Available at: https://www.plantwise.org/FullTextPDF/2012/20127801191.pdf, 2008.
[25] K. Balemie, R.K. Singh, Conservation of socioculturally important local crop biodiversity in the Oromia region of Ethiopia: a case study, Environ. Manag. 50 (3) (2012) 352–364, https://doi.org/10.1007/s00267-012-9883-9.
[26] D. Louette, M. Smale, Farmers' seed selection practices and traditional maize varieties in Cuzalapa, Mexico, Euphytica 113 (1) (2000) 25–41, https://doi.org/10.1023/A:1003941615886.
[27] N. Adedipe, P. Okuneye, I. Ayinde, The relevance of local and indigenous knowledge for Nigerian agriculture, in: Presented at the International Conference on Bridging Scales and Epistemologies: Linking Local Knowledge with Global Science in Multi-Scale Assessments, Alexandria, Egypt, 2004.
[28] M. Bezabih, K. Mekonnen, A. Adie, T. Tadesse, A. Nurfeta, W. Dubale, T. Habiso, T.Z. Kelkay, M. Getnet, K. Ergano, A.J. Duncan, Redesigning traditional weed management practices in faba bean fields to optimize food-feed production in the smallholder system, Agron. J. 114 (1) (2022) 248–258, https://doi.org/10.1002/agj2.20779.
[29] S.Z. Ndlela, M.V. Mkwanazi, M. Chimonyo, Factors affecting utilisation of indigenous knowledge to control gastrointestinal nematodes in goats, Agriculture 11 (2) (2021) 160, https://doi.org/10.3390/agriculture11020160.
[30] M.V. Mkwanazi, S.Z. Ndlela, M. Chimonyo, Utilisation of indigenous knowledge to control ticks in goats: a case of KwaZulu-Natal Province, South Africa, Trop. Anim. Health Prod. 52 (3) (2020) 1375–1383, https://doi.org/10.1007/s11250-019-02145-0.
[31] L. Badstue, P. Petesch, C.R. Farnworth, L. Roeven, M. Hailemariam, Women farmers and agricultural innovation: marital status and normative expectations in rural Ethiopia, Sustainability 12 (23) (2020) 9847, https://doi.org/10.3390/su12239847.