MEDIRES
Symbol of Quality Research

Journal of Food and Nutrition
info@mediresonline.org

ISSN: 2836-2276 REVIEW ARTICLE

Indigenous Knowledge in Termite Management of Agricultural Crops – A Review

Daniel Abebe[1*]

[1]*Jinka University, Department of Plant Science, College of Agriculture and Natural Resource, Southern Ethiopia.*
***Corresponding Author**: Daniel Abebe, Jinka University, Department of Plant Science, College of Agriculture and Natural Resource, Southern Ethiopia.

Received Date: 18 March 2024; **Accepted Date:** 02 April 2024; **Published date:** 05 April 2024

Citation: Daniel Abebe. (2024). Indigenous Knowledge in Termite Management of Agricultural Crops – A Review. Journal of Food and Nutrition. 3(1); DOI: 10.58489/2836-2276/026

Abstract

Some species of termites are becoming a threat to the farming community as they are directly and indirectly using major losses to the agricultural system. Reports on economic losses caused by termite infestations have been made worldwide. Intensive use of insecticides which is of great environmental and health concerns was the most frequently control option. To make termites management environmentally friendly, there is a need to integrate indigenous knowledge about pest management techniques into the scaling-up process in order to improve farmers' pest management practices. For centuries, humans planned agricultural production and conserved natural resources with the instruments of indigenous knowledge (IK). The development of indigenous knowledge systems is cumulative, representing generations of experience, careful observations, trial and error experiments. The objective of this review, we present the available information related to indigenous technology in termite management practices and to identify suitable and sustainable indigenous methods adopted by resource poor farmers for termite control.

Keywords: *Termites, management, Indigenous knowledge, agriculture, crops*

Introduction

Termite infestation is prevalent worldwide especially in the tropics where the distribution, problems and constraints result in livelihood threats, particularly among rural small-scale farmers [1 and 2]. Three thousand species of termites have been described, and only very few are considered to be the agricultural pests [3]. Termites originated from Sub-Saharan Africa, and species numbers are highest in rainforest habitats [4]. Across the world, there are more than 3016 termite species in 300 genera, Among the world fauna, 1000 species belong to African termite's fauna [5]. There are 61 species 25 genera and four families of termite in Ethiopia [6]. Termite fauna of Western Ethiopia include the genera: Macrotermes, Odontotermes, Microtermes, Amitermes, Microcerotermes, Angulitermes, and Trinervitermes. Out of these. Macroterms subhyalinus (Rambur) and Microtermes adschaggae (Sjosted) were the most abundant ones [7].

Termites are becoming a threat to the farming community as all major field crops such as cereals (rice, wheat, barley, maize, millet and sorghum), vegetables (tomato, okra, pepper, eggplant, potato and cassava), fruits (guava, citrus, banana, mango, papaya, grapes, mulberry, pineapple, almond, litchi and plum), legumes (beans, cowpea and chickpea), oilseeds (groundnut, sunflower, soybean and sesame) and ornamental plants are affected by termites [8-9]. Information on economic losses yield losses on maize crop in African countries varies, for example, in Kenya and Tanzania 30%, in Ethiopia 60%, in south western Nigeria 100% damage recorded [10].

Worldwide, termite control is commonly based on the use of chemical insecticides that have a negative impact on the environment and human health [11-12]. However, in Africa, farmers often use traditional pest management practices to control termites [2,11 &12]. The indigenous knowledge systems and technologies are readily available, socially desirable, economically affordable and sustainable and involve minimum risk to rural farmers and producers and above all they are widely believed to conserve resources [13].

Thus, indigenous agricultural practices are cost-effective, time-tested, eco-friendly and serve to

sustain agricultural development. Indigenous knowledge is developed and adapted continuously to gradually changing environments and passed down from generations to generations and closely interwoven with people's cultural values. It is also the social capital of the poor, their main asset to invest in the struggle for survival, to produce food, to provide for shelter or to achieve control of their own lives. In addition to documenting the traditional knowledge of the farmers, it is important to understand the ecological mechanisms behind their practices [14-16]. This is vital to application of traditional practices to new situations. Furthermore, and more importantly, the understanding of the traditional practices by outsiders may be useful for the empowerment of farmers at the local level [16-20]. To make termites management environmentally friendly, there is a need to integrate indigenous knowledge about termite management techniques into the scaling-up process in order to improve farmers' termite management practices. Therefore, the current review where to provide biology, distributions and farmer knowledge of termite with feasibility of control mechanism employed by farmers. Exploring such kinds of indigenous knowledge's of farmers was helpful to establish appropriate, inexpensive means of pest managements practice for the local community as well as for the other smallholder's farmers.

Materials And Methods

As a methodology the main source for this a literature review to capture insights on indigenous knowledge (IK), based on selected academic literature published in peer-reviewed journals, book chapters, and conference papers used to review. Through searching results 51 papers were retrieved and for the period of year of 1966-2023 and by reading abstract, introduction and conclusion parts data of these paper were identified that meet the objective of this report. Then, country of origin, year of publication, publisher, journal name, focus areas of the paper, methodology and findings of the paper were considered and analyzed.

Habit and habitat

Termites are xylophagus, principal food is cellulose. The workers feed on decaying wood, paper, fabrics and other fiber plants or the plant materials such as humus, grass, fungi, etc. The termites obtain nourishment from a cellulose diet distribution of termites because of presence of certain protozoa in their digestive tract, which possess enzymes capable of digesting cellulose. Termites usually avoid direct light. They make an irregular network of large interconnected galleries through which they travel from their nests to the food source. Oviposition by the primary queen will be low at first, but in due course of time she assumes massive morph measuring 2-4 inches and may give rise to a colony consisting of over a million termites. The individuals produced in a colony in the early stages are all sterile caste. The alate reproductive develop later on. When the colony becomes big enough the king and the queen, among higher termites, remain in a royal cell lodged deep in the termite mound [21].

Biology

Primary and supplementary reproductive adults are present in termite colonies. The primary reproductive are king and queen, which are the founder of the nest and colony. They are pigmented adults with initial fully developed wings. Their role is reproduction and the initiation of the colony. King or male reproductive goes for nuptial flights, copulates with the queen and fertilizes her by insemination. Queen or female reproductive stores the sperm in the spermathecae after the copulation and uses them to sire the unfertilized eggs. These adults mate only once. The main role for a queen is to produce eggs as she lays more than 3000 eggs per day, gradually enlarging her body, especially the abdomen, to accommodate the eggs [22]. These are yellowish-white in colour, and the incubation period may be prolonged to 50– 60 days. After incubation, the nymphs hatch out in the form of neonates. They undergo a number of molting's before becoming adults. The termites are hemimetabolous, undergoing an incomplete metamorphosis. Unlike most other insects, very little is known about molting in termites, particularly in the subterranean group. Reasons for this lack of information include the absence of synchronization in the timing of molt, the cryptic nature of subterranean termites and their long-life cycle. It takes about 4– 5 years for a termite colony to reach its maximum size, with more than 60,000–200,000 workers. These further modify into sterile soldiers or remain as sterile workers during the course of time. Morphologically, the workers and soldiers are 6–8 mm in length and pale cream in colour. The soldiers have enlarged heads with black jaws. Both workers and soldiers are devoid of wings and usually lack eyes [23]. The life cycle of termites starts with the dispersal of winged reproductive to colonize new resources. The mating pair sheds their wings and establishes a new nest. Then the queen oviposits, the eggs hatch and the nymphs develop into different forms. The castes are determined during post-embryonic development, and each larva (first or second instar termite) can become

a worker, soldier or reproductive [24]. The reproductive caste can have multiple forms reviewed by [25] the primary reproductive are alate derived and are the king and queen in the colony. A neotenic reproductive is a reproductive that is not derived from an alate and still retains some juvenile characteristics.

Ecology

Ecologically, the termites act as "ecosystem engineers" as they influence processes and properties of soil structure and hydrology, nutrient availability, and organic matter decomposition. They affect the productivity and composition of plant communities by tunneling, breakdown and deposition of organic matter (saliva and feces), and soil translocation [26-27]. Many termite species produce methane and fix atmospheric carbon and nitrogen via symbiotic microorganisms in their hindgut, thus making them available to other soil organisms [28-29]. However, the amount of methane is negligible (between 0.02 and 0.09 Tg year−1) as compared to other non-termite sources (over 600 Tg year−1) [27 &30]. They serve an important ecological role in the decomposition of cellulose materials that cannot be chemically broken down without the presence of the enzyme cellulase secreted by single-celled protozoans [31]. Termite can produce up to 2 liters of hydrogen from digesting a single sheet of paper, making them one of the most efficient bioreactors on the planet [32].

Yield losses

Termites are highly destructive and polyphagous pests of crop plants, which damage green foliage, seedlings, wood, fibers including household cellulose-based materials, and postharvest stored products [33]. Most of the pest species are able to reduce yields significantly, and the crop losses may exceed over 100% in regions such as East Africa and North Asia [34]. Usually they infest roots, woody tissue, and leaves of eucalyptus, upland rice, and sugarcane. Further, cassava, coffee, cotton, fruit trees, maize, peanuts, soybeans, and vegetables are other hosts of termites. [35] suggested that the plants which are being stressed by biotic (insects' pests and diseases) and abiotic factors (drought, nutrient deficiency etc.) attract more damage by termites. Infestation due to termites was observed up to 20-25% in rainfed and up to 10% in irrigated crops [36]. Such losses are more pronounced in ergonomically and physiologically poor soils. Globally, the estimated loss due to termite damage is about 50 billion USD [37], although estimates vary considerably by the cropping systems followed in different geographical regions. Losses due to termite attack had been observed to be up to 25-30, 10-15 and 5-17% in cowpea (Vigna sinensis), moth bean (*Phaseolus aconitifolius*) and moong (*Phaseolus radiatus*), respectively [38]. Yield losses occurred in cereal crops 13-80, 50-100, 67-85% in wheat, rice and maize, respectively [29,40,41]. Infestation in horticulture crop such as mango, lemon and apple cinnamon the termite infestation observed is recorded up to 80, 58 and 11.11%, respectively [42]. Yield losses in oil seed Groundnut 10-30% [38], 33% in soybean [43].

Management of termites

Termites are difficult to manage due to their dynamic living strategies which make them major destruction in different crops. Most of the species live in underground nests with ramification of galleries, so it is rather difficult to locate and reach them. Regular monitoring of fields to detect activities of termites and their damage can save the plants from damage. At present, chemical control is the major component for management [44&45]. But due to increasing concern about their harmful environmental effects, there is a need to find out ecofriendly approaches for its management by keeping the chemical control as a last resort. Several techniques for IPM programme are available

Indigenous approaches for the management of termite

Different indigenous knowledge for termite managements have been used by different communities in different parts of the country to protect their crop from termites. Research conducted in Gushegu-Karaga district in the northern region of Ghana indicated that Five termite prevention and control methods were identified: - burial of plant and animal materials, application of wood ash, application of a mixture of salt and Shea butter residue, planting of elephant grass and 'banchi' methods. Planting of elephant grass was found to be the most common method used by the farmers, while burial of plant and animal materials was found to be the most effective method of termite control in the area. Despite their well-known role as pests, termites are considered important in the area because they provide necessary ecosystem services [46]. In Ethiopia, traditional knowledge employed to control termite methods are employed to shift away from the stress or to devise a means to tolerate termites. [47] stated that, farmer's that pain with termites' problems used different methods of indigenous termite control. Traditional termite management varies with the farmer practices

often termite venerable areas are more adopting the management. Flooding mounds, queen removal with mound destruction, and suffocating mound with straws in excavated top of mounds, powering dissolved salt+pepper+areke and tela residue, manually removing galleries from the wall of house, adding ash to mounds established in house, using termite resistant plant for construction, keeping harvested teff on craton leaf, making heap of crops on base made of termite resistant wood, traditional storage structures are among cultural methods practiced in the central rift valley of Ethiopia. Research report at western Ethiopia by [48] among the indigenous termite management practices, results underline that the farmers relay on disturbing mound by digging to exclude termite queen, flooding termite mounds, sealing of mound with chopped removed weeds, adding pepper dissolved with ash, and salt, irrigating with tela and areke residue (atela), got urine mixed with hot animal dung to cause suffocation that might induce termite removal from their farm. Similarly, in Eastern Wollega conducted research farmers use different strategies to minimize the effect of termite on maize: plant tolerant crop type, smoking mounds using peppers pods or eucalyptus trees leaves, Hoe weeding practice or ridging soon after rain use high seed rate or replanting, using hot ashes around house and field, directing water runoff into ant hills, physical removal Queen were found to be the most effective indigenous method of termite control in the area [49]. Moreover, indigenous knowledge of termites control methods in five farming communities in Gadau district Bauchi state Nigeria were identified these methods included: Cow urine + Pepper application, Direct pouring of water on termite nest, Wood ash and Salt in shea butter residue [50]. In Case of Nedjo District, West Wollega, Ethiopia, the research found that the main traditional control methods practices by the farmers are: digging the mound and removal of the queen; flooding the termite nest; Smoking with crop residues, hot pepper and cow dung; Applying wood ash, hot local alcohol residues, gas or salts; Planting termite tolerant trees, herbs and grasses [51].

Conclusion

In contrast to modern technologies, indigenous termite control practices do not involve as termite control chemicals as they utilize locally available bio resources. Hence, indigenous termite control practices may be propagated and promoted not only for the benefit of the people but also for maintaining agricultural sustainability and ecological balance. In the present review, majority of the indigenous termite control practices are found to be rational and effective and such practices will definitely be valuable, and may be directly recommended for adoption in order to ensure sustainable farming. Hence, efforts to improve the knowledge and adoption of indigenous practices by the farmers may be undertaken which would act as an impetus for promotion of indigenous practices which are ecofriendly and conserving natural resources. Further, concerted efforts should be made to collect and document various indigenous knowledge/practices in the field of agriculture, before they become extinct.

References

1. Fenemore, P.G. (2006) Applied entomology. New Age International. (P) Ltd publishers. 200-203
2. Sileshi, G., Akinnifesi, F. K., Ajayi, O. C., Chakeredza, S., Mng'omba, S., & Nyoka, B. I. (2008). Towards sustainable management of soil biodiversity in agricultural landscapes in Africa. Biodiversity, 9(1-2), 64-67.
3. Brune, A. (2014) Symbiotic digestion of lignocellulose Ambio in termite guts. Nature Reviews Microbiology. 12, 168–180
4. Poulsen, M., Hu, H., Li, C., Chen, Z., Xu, L., Otani, S., ... & Zhang, G. (2014). Complementary symbiont contributions to plant decomposition in a fungus-farming termite. Proceedings of the National Academy of Sciences, 111(40), 14500-14505.
5. Kumarkrishna, D., Grimald, V.K., and Michael, S.E. (2013) treatise on the isoptera of the world. 7. references and index
6. Ahmed, B. M., Nkunika, P. O. Y., Sileshi, G. W., French, J. R., Nyedo, P., & Jain, S. (2011). Potential impact of climate change on termite distribution in Africa. British Journal of Environment and Climate Change, 1(4), 172-189.
7. Abdurahman, A. (1990) foraging activity and control of termites in western Ethiopia. A thesis submitted for the degree of Doctor of Philosophy of the University of London and for the Diploma of Imperial College Department of Pure and Applied Biology Imperial College of Science, Technology and Medicine Silwood Park Ascot
8. Rathour, K. S., Ganguly, S., Das, T. K., Singh, P., Kumar, A., & Somvanshi, V. S. (2014). Biological management of subterranean termites (Odontotermes obesus) infesting wheat and pearl millet crops by entomopathogenic nematodes. Indian Journal of Nematology, 44(1),

97-100.

9. Lin, Y., Fang, D., & Wang, L. (2015). Termites and microbial biological control strategies Muhammad Qasim. South Asia, 1(6).
10. Gitonga, W., Kusewa, T.M., Ochiel, G.R.S. (1995) Comparison of chemical and cultural against termites in Western Kenya. In proceedings of second regional Workshop on Termites Research. March 7-9, Nairobi Kenya. 1995, 169-216.
11. Yêyinou Loko, L. E., Orobiyi, A., Agre, P., Dansi, A., Tamò, M., & Roisin, Y. (2017). Farmers' perception of termites in agriculture production and their indigenous utilization in Northwest Benin. Journal of ethnobiology and ethnomedicine, 13, 1-12.
12. Sileshi, G. W., Kuntashula, E., Matakala, P., & Nkunika, P. O. (2008). Farmers' perceptions of tree mortality, pests and pest management practices in agroforestry in Malawi, Mozambique and Zambia. Agroforestry systems, 72, 87-101.
13. Grenier, L. (1998). Working with indigenous knowledge: A guide for researchers. idrc.
14. Gliessman, S. R., Garcia, R. E., & Amador, M. A. (1981). The ecological basis for the application of traditional agricultural technology in the management of tropical agro-ecosystems. Agro-ecosystems, 7(3), 173-185.
15. Vanek, E. (1989). Enhancing environmental resource management in developing nations through improved attitudes towards indigenous knowledge systems: the case of the World Bank.
16. De Walt, B. (1994) Using indigenous knowledge and natural resource management to improve agriculture and natural resource management. Human Organization. 53(2): 123– 131.
17. Freire, P. (1968) Pedagogy of the Oppressed. New York: The Seabury Press.
18. Patton, M. Q. (1990). Qualitative evaluation and research methods. SAGE Publications, inc.
19. Barzman, M. S., Mills, N. J., & Thu Cuc, N. T. (1996). Traditional knowledge and rationale for weaver ant husbandry in the Mekong delta of Vietnam. Agriculture and human values, 13, 2-9.
20. Sillitoe, P. (1998). The development of indigenous knowledge: a new applied anthropology. Current anthropology, 39(2), 223-252.
21. Mahapatro, G. K., & Sreedevi, K. (2014). Indigenous approaches for the management of termite and white grub in upland rice.
22. Thompson, G. (2000) Termites (Tropical topics newsletter No. 64, pp. 1–8). Tropical Savanna CRC, Environmental Protection Agency, The State of Queensland, Australia.
23. Myles, T. G. (2005). Termite biology, urban entomology programme''. Online at http://www.utoronto.ca/forest/termite/termite.htm
24. Lainé, L. V., & Wright, D. J. (2003). The life cycle of Reticulitermes spp.(Isoptera: Rhinotermitidae): what do we know?. Bulletin of Entomological research, 93(4), 267-278.
25. Thorne, B. L. (1996) Termite terminology. Sociobiology. 28, 253–263.
26. Wickings, K., & Grandy, A. S. (2011). The oribatid mite Scheloribates moestus (Acari: Oribatida) alters litter chemistry and nutrient cycling during decomposition. Soil Biology and Biochemistry, 43(2), 351-358.
27. Maynard, D. S., Crowther, T. W., King, J. R., Warren, R. J., & Bradford, M. A. (2015). Temperate forest termites: ecology, biogeography, and ecosystem impacts. Ecological Entomology, 40(3), 199-210.
28. Breznak, J. A., Brill, W. J., Mertins, J. W., & Coppel, H. C. (1973). Nitrogen fixation in termites. Nature, 244(5418), 577-580.
29. Brussaard, L. (1997). Biodiversity and ecosystem functioning in soil. Ambio, 563-570.
30. Brune, A. (2010) Methanogens in the digestive tract of termites. In J. H. P. Hackstein (Ed.), Microbiology monographs pp. 81–100. Berlin/Heidelberg: Springer
31. Pearce, M. (1997) Termites: Biology and pest management (1st ed.p. 172). Chatham: CAB International
32. Ibrahim, B. U., & Adebote, D. A. (2012). Appraisal of the economic activities of termites: A review. Bayero Journal of Pure and Applied Sciences, 5(1), 84-89.
33. Upadhyay, R. K. (2013). Effects of plant latex based anti-termite formulations on Indian white termite Odontotermes obesus (Isoptera: Odontotermitidae) in sub-tropical high infestation areas. Open Journal of Animal Sciences, 3(04), 281.
34. Saathoff, E., Olsen, A., Kvalsvig, J. D., & Geissler, P. W. (2002). Geophagy and its association with geohelminth infection in rural schoolchildren from northern KwaZulu-Natal, South Africa. Transactions of the Royal Society of Tropical Medicine and Hygiene, 96(5), 485-

490.

35. Heinrichs, E. A., Barrion, A. T. (2004) Rice-feeding insects and selected natural enemies in West Africa: biology, ecology, identification. International Rice Research Institute, Los Banos, Philippines. 242 pp.
36. Sharma, A. K., Babu, K. S., Nagarajan, S., Singh, S. P., & Manoj, K. (2004). Distribution and status of termite damage to wheat crop in India. Indian Journal of Entomology, 66(3), 235-237.
37. Subekti, N., Yoshimura, T., Rokhman, F., & Mastur, Z. (2015). Potential for subterranean termite attack against five bamboo speciesin correlation with chemical components. Procedia Environmental Sciences, 28, 783-788.
38. Paul, B., Khan, M. A., Paul, S., Shankarganesh, K., & Chakravorty, S. (2018). Termites and Indian agriculture. Termites and Sustainable Management: Volume 2-Economic Losses and Management, 51-96.
39. Roonwal, M. L. (1979). Termite life and termite control in Tropical South Asia.
40. Anonymous. (2000) Global IPM Facility Expert group on termite biology and management. Finding alternatives to persistent organic pollutants (POPs) for termite management''. www.chem.unep.ch/ pops/termites/termite_ch4.htm.
41. Mphosi, M. S., Nthangeni, S.H., du Plessis, U. M., Rossouw, A.L. (2009) Identification of termites causing damage in maize in small scale farming systems. Project report. Limpopo Department of Agriculture, University of Limpopo, ARC-PPRI. 11 pp
42. Moïse, A. A. A., Perrine, K. T. A., Séraphin, D. Y. K., Tenon, C., & Hervé, K. K. (2018). Diversity and damages of termites on papaya trees (Carica papaya) in M'brimbo (south of Côte d'ivoire). International Journal of Entomology Research, 3(6), 60-64.
43. Bigger, M. (1966). The biology and control of termites damaging field crops in Tanganyika. Bulletin of Entomological Research, 56(3), 417-444.
44. Peterson, C., Wagner, T.L., Mulroney, J.E, Shelton, T. G. (2006) Subterranean Termites-Their Prevention and Control in Buildings. USDA Home and Garden Bulletin 64 p.
45. Potter, M F. (2011) Termites. Handbook of pest control: the behavior, life history, and control of household pests. 10th ed. Mallis A et al. (eds.). Cleveland: GIE Media Inc., 1600 pp.
46. Maayiem, D., Bernard, B. N., & Irunuoh, A. O. (2012). Indigenous knowledge of termite control: A case study of five farming communities in Gushegu District of Northern Ghana. Journal of Entomology and Nematology, 4(6), 58-64.
47. Debelo, D. G., & Degaga, E. G. (2017). Study on termite damage to different species of tree seedlings in the Central Rift Valley of Ethiopia. African Journal of Agricultural Research, 12(3), 161-168.
48. Temesgen Beyene and Oljira Kenea (2020). Farmers' Perception of Termite Infestation and Their Indigenous Management Practices in Abe dengoro Resettlement Areas, Western Ethiopia. Journal of Biology, Agriculture and Healthcare. Vol.10, No.5.
49. Abebe, D., & Tesfaye, Y. (2023). Prevalence, Farmers Knowledge, Perceptions and Managements Practices of Termites on Maize (Zea mays L.).
50. Hassan, I., & Nasiru Disina, J. (2020). Indigenous knowledge of termites control methods in five farming communities in Gadau district Bauchi state Nigeria. Acta Entomology and Zoology, 1(1), 26-30.
51. Aliyi, A. D. (2017) The Role of Farmers' Indigenous Knowledge in Integrated Termites Management Strategies: A Case of Nedjo District, West Wollega, Ethiopia''. Van Hall Larenstein University of Applied Sciences in Partial Fulfillment of the requirements for the degree of Master in Management of Development, specialization Rural Development and Food Security