Indigenous practices for protecting groundnut (Arachis hypogaea L.) crops against pests and diseases in Saurashtra region, Gujarat, India

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Abstract: The study was carried out in the Junagadh district of Gujarat, India, with the aim of recording the traditional procedures used by Indigenous groundnut producers (Arachis hypogaea L.) to reduce the negative effects of pests. The research assessed various cost-effective pest management strategies. Employing intensive surveys with a sample of 120 groundnut farmers from twelve villages in the Saurashtra region, we catalogued 40 indigenous pest control techniques across different crop production stages, with 23 practices deemed scientifically rational. Analysis revealed that 74% of the surveyed farmers utilized open furrow techniques during the pre-sowing phase, with a significant proportion adopting early sowing, movable lighting to repel blue bulls, and pod drying after harvesting. These practices were characterized by their low cost and environmentally sustainable nature, relying on locally-sourced inputs. Among the methods evaluated, pod drying after harvesting and open furrows were identified as the most effective and economical for controlling pests and diseases.

Keywords: Blue bull (nilgais), Groundnut, Pests, Indigenous practices, Rural food production

Introduction

Groundnut, scientifically known as Arachis hypogaea L., is a significant crop worldwide. It plays a crucial role in supporting livelihoods that rely on agriculture by providing food, nutrition, and financial stability. According to Willett et al. (2019), it provides a substantial amount of protein, calories, essential fatty acids, vitamins, and minerals, making it an important source of nourishment for humans. Consuming groundnuts is associated with a multitude of health advantages (Kris-Etherton et al., 2008).

Junagadh, located near the Gir Sanctuary in Gujarat, India, faces challenges from wild and domesticated animals that intrude into groundnut fields during the cropping season. According to a study conducted by Chhangani and Mohnot (2004), farms located near the boundary of the sanctuary and those with insufficient measures to safeguard crops are most susceptible to experiencing loss of crops. In the Saurashtra region of Gujarat, white grubs (*Holotrichia consanguinea* and related species) are prominent soil-dwelling pests affecting groundnut cultivation. Fourteen species of white grubs have been documented in these areas (Kapadia *et al.*, 2006). Additionally, depredatory birds and wild boars are major causes of crop damage (Rao, 2000).

For generations, farmers in this region have developed significant knowledge and practices related to crop and herd management through continuous observation and experimentation. This includes the creation of tools and techniques to optimize resource use, enhance production, improve processing and storage, and reduce pest damage. Oral transmission of this "traditional and local knowledge" (TLK) puts it at risk of disappearing unless concerted efforts are taken to record and preserve it.

Several Indigenous Technical Knowledge (ITK) practices were documented through field investigations. Nevertheless, certain Indigenous Traditional Knowledge (ITKs), which encompass farmer inventions or distinctive amalgamations of traditions, have yet to be recorded in any other sources. These primarily involve the use of botanicals for various pests management (Balamati, 2000). It is crucial to understand the scientific rationale behind these traditional practices (Talwar and Singh, 1991). TLK practices encompass both technical and non-technical fields, incorporating social and religious taboos, value, customs, communication modes, ecology, music, beliefs, vegetation and weather, including monsoons. These traditional farming practices are grounded in wisdom and logic, increasingly recognized and supported by scientific studies. Local farmers protect their crops by maintaining a 24-hour vigilance during the growing season, using dogs, scarecrows, and more recently, nylon net covers and high-voltage electric fences to deter wild animals (Meena *et al.*, 2012; Patel *et al.*, 2016).

Crops are enhanced through crop rotation, use of crop residues, growing legumes, adding animal and green manure, off-farm organic waste, and employing biological pest control

(Bhattacharyya, 2004). These practices are derived from the collective wisdom of farmers in dealing with specific conditions and issues. They may differ throughout countries, regions, and individual farms, but effective practices are often discussed and implemented. This study documents and reviews indigenous pests and disease control practices employed by groundnut growers from a scientific perspective, aiming to inform and develop policy interventions to enhance the crop's productivity and production extent.

Materials and Methods

The work is performed based on an *ex-post facto* research design, employing a multistage simple random sampling technique. The Junagadh district in Gujarat was selected due to its leading position in groundnut cultivation (**Fig. 1**). Junagadh's proximity to Gir Sanctuary results in frequent crop damage from wild and domestic animals, particularly during the *kharif* season. Groundnut pests in this region include white grubs (*Holotrichia consanguinea*), *Heliothis*, and aphids, along with diseases such as stem rot, all of which have significantly impacted groundnut crops over the past decade.

Out of the district's nine talukas, three were selected based on the extent of their groundnut cultivation areas and their proximity to Gir Sanctuary, which makes their crops highly vulnerable to animal and pest damage (**Fig. 1**). From each of the three talukas, four villages were randomly selected, total twelve villages. From each village, ten groundnut growers were randomly chosen, resulting in a sample size of 120 groundnut farmers. A list of 40 Indigenous and Local Knowledge (ILK) practices was compiled based on input from progressive farmers. Following discussions with experts and farmers, 23 practices were selected for detailed examination. Questionnaires were administered to gather data on each farmer's practices. The collected data were coded, entered into a spreadsheet, and analyzed statistically, with the mean average used to determine the frequency of each practice.

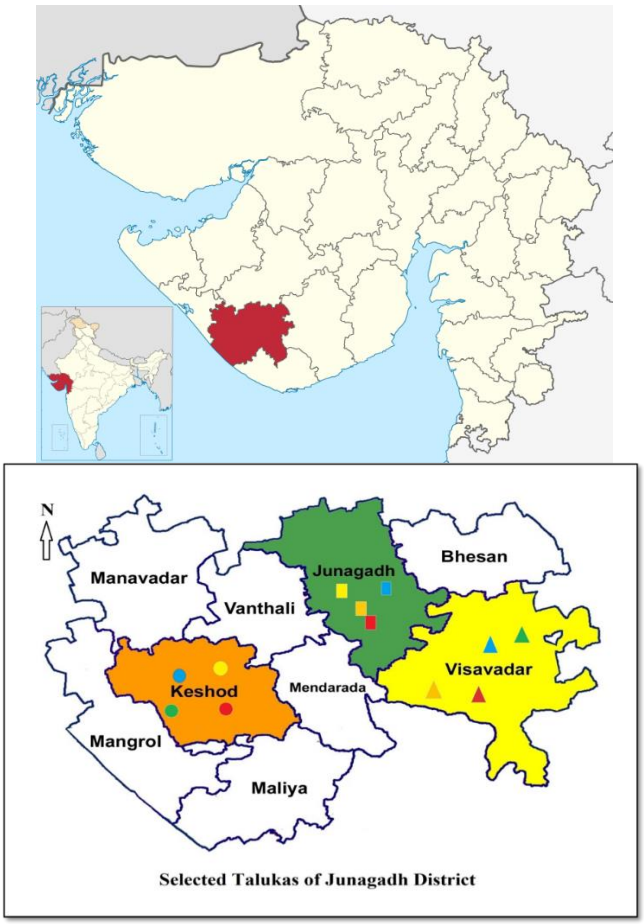

Fig. 1: Selected talukas of Junagadh district of Gujarat state, India, for data collection.

Results and Discussion

Several innovative practices rooted in Indigenous Technical Knowledge (ITK) were employed by the farmers we interviewed to deter depredatory birds, wild animals, and insect pests, and to protect

groundnut crops from disease. Some of these practices were scientifically evaluated and validated as effective and economically feasible (**Table 1**).

Table 1: Distribution of farmers based on their documentation and rationalism of practices followed to protect the groundnut from pests (n = 120)

Sr. No.	Timing and strategies for groundnut crop protection	Frequency of use	Percentage of farmers using	level of frequency
A.	**Pre-Sowing phase**			
1	Opening furrows	89	74.16	I
2	Deep ploughing	75	62.50	II
3	Stone walls to exclude wild animals from crop	56	46.66	III
4	Hanging shining coloured video/audio/strips	52	43.33	IV
5	Placing scarecrows in field	46	38.33	V
6	Use of live fencing exclude wild animals from crop	31	25.83	VI
7	Burning over field to control white grub	19	15.83	VII
B.	**Sowing phase**			
1	Early sowing of groundnut	77	64.16	I
2	Seed treatment to reduce pest damage	62	51.66	II
3	Crop rotation	58	48.33	III
C.	**After sowing**			
1	Movable light use for repel to blue bull	70	58.33	I
2	Wild animals keep far away by metallic noise	67	55.83	II
3	Border of saree around the field	61	50.83	III
4	Use of castor bean husks as manure and pests control	46	38.33	IV
5	Application of cow urine repels wild animals	20	16.66	V
6	Dragon fly used as indicator of pests in groundnut crop field	4	3.33	VI
7	Using constellations to control pest	4	3.33	VII
D.	**Harvesting/ After harvesting**			
1	Pods dried	97	80.83	I
2	Neem leaf mixed with stored groundnuts	38	31.66	II
3	*Chullah* ash mixed with groundnuts to reduce pest damage in storage	14	11.66	III
4	Tobacco mixed with stored groundnuts	9	7.50	IV
5	Birds kept away from crop by nets	7	5.83	V
6	Using the almanac for storage (2^{nd}-fortnight of Hindu month)	6	5.00	VI

Sequential contributions of respective practices among categories are summarized below:

A. Pre-Sowing phase

The most frequently employed pest control practice among farmers during the pre-sowing phase was “opening furrows”, utilized by approximately 75 percent of the farmers (**Fig. 2**). This practice facilitates soil solarization before the monsoon season, establishes guidelines for sowing and crop spacing, aids in the collection of manure, and enables water sequestration in areas with insufficient rainfall.

Deep ploughing was identified as the second most prevalent practice during the pre-sowing phase. Groundnut growers reported that this method helps expose insect pest eggs, pupae, pathogens, and spores. Deep ploughing also eliminates white grubs and cutworm larvae through soil solarization and uproots deep-rooted weeds while destroying weed seeds through exposure to heat. The third most common strategy in this phase was constructing stone walls to protect crops from wild animals (**Fig. 2**). Additionally, the use of reflective tapes, such as video/audio strips, was frequently employed. These tapes deter blue bulls (*nilgais*) by creating glare during the day from sunlight and reflecting light at night, as they are tied to wooden stakes around the crop fields.

Another widely employed pest management practice among groundnut farmers involved the use of scarecrows (**Fig. 3**) to deter birds and animals from the fields. Blue bulls, which generally avoid human presence, are discouraged from entering the fields when humans are not present. Scarecrows

designed to resemble human figures, placed in the center of the fields, create the illusion of human activity and effectively prevent blue bulls and birds from entering the crop areas.

Live fencing (**Fig. 3**) is an effective and low-cost method used to protect crops from blue bulls, pigs, and wild animals. Historically, farmers had limited options for securing the boundaries of large fields due to the scarcity of building materials and the high cost of traditional fencing. As a result, farmers adopted live fencing using *Opuntia* cactus, known locally as "thor" (meaning "thorn"), and the common milk hedge or Indian spurge tree (*Euphorbia neriifolia*). Thor, a hardy and thorny plant, thrives with minimal water and is typically planted from cuttings during the summer months of May and June. When grown in a continuous line along the field's edge, thor reaches a height of 1 to 1.5 meters, forming a robust barrier that effectively deters both humans and animals. Additionally, controlling white grubs and other pests is achieved by burning crop residues and other materials in the field, which destroys pest eggs and pupae in the soil.

Fig. 2 - Opened furrow and stone wall
(Source: www.featurepics.comonlineFurrows-Field-2947343.aspx)

Fig. 3 - Live fencing and scarecrows
(Source: https://thannal.comnatural-and-living-fence) ; https://www.pikist.comfree-photo-xbfpl)

B. Sowing phase

Early sowing of groundnut emerged as the most effective pest control strategy during the sowing phase, with approximately 65 percent of farmers implementing this method (**Fig. 4**). Farmers noted that early sowing enabled them to reduce irrigation requirements and achieve higher yields, as it allowed the crop to establish itself adequately before the onset of the monsoon. Additionally, early planting minimized crop diseases and insect infestations. Another prevalent pest management practice during the sowing phase was the treatment of seeds with fungicides or natural pesticides, such as neem leaf (*Azadirachta indica*) kernel extracts. This approach was demonstrated to be a simple and cost-effective means of reducing the disease which are seed-borne and also controlling white grub.

Crop rotation was identified as the third most common practice during the sowing phase (**Fig. 4**). Sequential planting of different crops in the same field is a well-established practice in the region. Farmers commonly rotate between groundnut and *Sesamum sp.* (sesame) to reduce pest risk. Scientists observe that sesame, with its deep root system, extracts nutrients from deeper soil layers,

while the shallower-rooted groundnut utilizes nutrients from the upper soil layers. Additionally, some farmers implement a rotation between castor (*Ricinus communis*) and groundnut, which is reported to assist in weed and pest control.

Fig. 4 - Early sowing of groundnut and crop rotation
(Source: www.agrifarming.in)

C. After sowing

The most prevalent method for protecting groundnut crops in the post-sowing phase is the use of movable lighting to repel blue bull antelopes (*nilgais*), with nearly 60 percent of farmers employing this technique (**Fig. 5**). When farmers aren't in the fields, especially at night, these lights work well to ward off the animals. Metallic sounds (**Fig. 5**) were also commonly used to keep animals away during periods of farmer absence. Another method involved placing saree borders (**Fig. 6**) around the fields; the colorful, moving fabric was effective in frightening pigs, other animals, and birds during the day. Additionally, castor husks were used both as manure and for pest control following crop sowing (**Fig. 6**). Scientific observations confirm that the pesticidal properties of this manure enhance its effectiveness, providing control against aphids and certain fungal diseases that could otherwise result in 20-50 percent yield losses. Furthermore, this manure helps reduce termite infestations in subsequent winter wheat crops.

The application of cow urine, sprayed around the borders of crops, effectively repels wild animals. Beneficial predators like dragonflies, when present around the groundnut field denotes the presence of pest. However, this knowledge is only known to a subset of farmers. Pest and disease outbreaks are influenced by the simultaneous occurrence of three factors: rainfall in August, bright sunny days in September (Magha, Purba, Uttara, and Hasta), and southeast winds. Farmers observe these conditions as indicators of pest presence, such as aphids during Magha. It is reported that there is a direct correlation between temperature and humidity which promotes more occurrence of pest.

Fig. 5 - Movable light and metallic sound produce
(Source: www.indiamart.com; www.sheknows.com)

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Fig. 6 - Border of saree and castor cake

D. Harvesting/ After Harvesting

Over 80 percent of farmers adhered to prescribed practices for groundnut pest protection during and after harvesting. The most frequently used practice was drying the pods, a technique passed down through generations (**Fig. 7**). This method reduces the incidence of aflatoxin infection and decreases attacks from storage pests such as *Sitophilus oryzae*, the groundnut *bruchid*s. Following pod drying, the next most common practice was mixing neem leaf extract with stored groundnuts (**Fig. 7**), which helps control aphids and whitefly, among other pests. Additionally, farmers mix ash from *chullah* stoves with stored groundnuts to mitigate pest damage. For preventing the seeds from insect pest, farmers are applying the protective coat of ash, around the seed. For keeping the pests away in the groundnut, Tobacco (*Nicotiana tabacum*) is also mixed during storage. As tobacco is having the toxic alkaloid named nicotine, which has been used as an organic pesticide for hundreds of years on a small scale basis which is now receiving new scientific attention as a potential mass-produced alternative to commercial pesticides that have been used recently. Gardeners have historically utilized homemade mixtures of tobacco and water as a natural insecticide. During harvesting, birds are deterred from crops using nets, which are effective, unobtrusive, and durable. However, after threshing, the nets must be collected and carefully stored. Groundnut storage timed to coincide with the dark moon cycle, specifically the second fortnight of the Hindu month, is also a strategy for pest protection. Farmers believe this practice helps eliminate pest infestations in stored crops.

Fig. 7 - Drying of pod and neem leaf
(Source: www.alarmy.com; www.depositphotos.com)

Conclusion

Groundnut growers in the Saurashtra region of India employ a diverse range of practices to protect their crops from insect pests, diseases, animals, and birds. Key pest control methods practiced by these farmers include the use of open furrows, early sowing, and seed treatment with repellent substances. They also use movable lights to deter blue bull antelopes from entering fields near the Gir Sanctuary. Drying the groundnut pods immediately after harvesting helps prevent aflatoxin infestation. Additionally, mixing neem extract with dried groundnuts aids in controlling insect pests. These applied TLK practices effectively reduce crop damage and maintain high yields.

Some of these practices have been scientifically validated, while others require further investigation. Recording this knowledge is critically important, as many indigenous knowledge systems

are at risk of disappearing due to rapidly changing natural environments and fast-paced economic, governmental, and cultural shifts globally. This project represents an effort to conserve, promote, and document such indigenous traditional knowledge and practices in an agricultural context. Combining traditional and scientific knowledge necessitates partnerships and collaborations between local farmers and researchers, ultimately benefiting efforts towards greater sustainability.

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Author's Contribution
P. H. Zala: Conceptualization, Investigation, Data Collection; N. B. Jadav: Project administration, Supervision; Himalay R. Patel: Writing- Final Draft; V. S. Ranpariya: Writing- Support in Reference writing; Saryu Trivedi: Writing- Review; and Harsh Kamani: Writing- References

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Data availability
The datasets produced and/or analyzed throughout the course of the present study can be accessed upon reasonable request from the corresponding author.

Declarations
Conflict ofInterests
The authors affirm that they harbor no competing interests that could potentially influence the content presented in this article.

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