

## Indigenous traditional practices for the insect-pest and weed management in Bilaspur and Una Districts of Himachal Pradesh (India)

Divya, Shivani Thakur, Mamta Verma, Deepti Gupta, Suresh Kumar\*

Department of Bio-Sciences, Himachal Pradesh University, Shimla, Himachal Pradesh, India

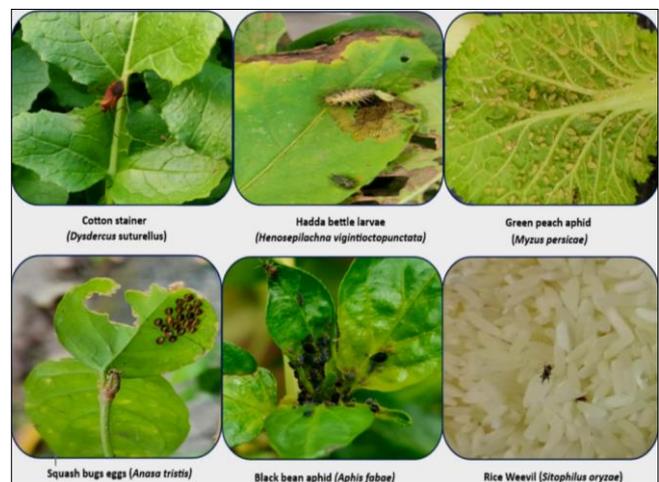
### Abstract

Modern agriculture cannot sustain itself properly without controlling insect-pests and weeds since they can drastically lower crop quality and productivity. Management of pests and weeds is crucial to both landscaping as well as agriculture. Despite their effectiveness, chemical pesticides and herbicides have caused environmental concerns because of their negative effect on soil health, human safety and non-target organisms. Exploring sustainable options that support ecological preservation and agricultural resilience is imperative. Traditional insecticidal and weed management practices have played a crucial role in preserving sustainable agriculture. This paper advocates the traditional methods of weed and pest management in Bilaspur and Una districts of Himachal Pradesh. Weed management in cropped lands of study area involves traditional methods like mulching, mixed cropping, hand pulling, mowing, and crop rotation. Local inhabitants also use mixtures like sour buttermilk, leaf-based herbal mixtures, citrus-vinegar and herbal weedicides to control weeds. For non-cropped areas, manual removal and community efforts are common, and weeds are often repurposed for various innovative uses. On the other hand, for pest control, local farmers use simple methods like spreading ash, applying cow urine with plants, mixing cow dung for natural pesticides and using butter milk to trap pests. *Azadirachta indica* is particularly valued for its powerful insecticidal and insect repellent properties. Natural insecticidal properties are found in plants such as tobacco, neem and adusa which are effective in repelling and controlling pests. These natural agents are environmentally acceptable substitutes because they show less toxicity to non-target organisms and less environmental persistence. Even with its benefits, organic weed and pest control can be difficult to apply and needs careful planning and observation. The future of natural weed and pest control in agriculture will be greatly influenced by the fusion of traditional knowledge and cutting-edge technologies.

**Keywords:** Traditional practices, pest control, weed management, sustainable agriculture

### Introduction

Major crops experience approximately 35% yield loss worldwide due to the impact of arthropods, weeds and diseases. In developing regions with limited pest control options, such losses can surpass 50%. Damage caused by pests, especially arthropods can result in significant losses or even complete crop failure (Fig. 1). This emphasizes the crucial importance of crop protection in preserving yields and securing food supply (Dougoud *et al.*, 2019) [3]. Farmers typically depend on synthetic insect-pest control methods, primarily using synthetic chemical, to safeguard their crops as well as stored grains from pest infestations. Although synthetic pesticides are highly effective, their repeated use presents challenges, including the emergence of pesticide-resistant pests. Excessive and improper use of synthetic pesticides can harm human health, damage the environment and pose a threat to non-target organisms, ultimately reducing biodiversity. Traditional insect-pest control methods utilizing plant-based alternatives remain widely practiced and favoured among farmers for preserving field crops. Plants containing bioactive compounds have been effectively used to control various crop pests. Herbal pesticides are commonly found in the environment and many of them serve multiple purposes, including use as medicine, food, animal feed, ornamental and spice. Their accessibility makes them affordable, allowing for easy integration into agricultural production systems. Commercial pesticides derived from plants like pyrethrum, neem and sabadilla are among the least toxic, particularly to non-target organisms such as pollinators and fish (Lengai *et al.*, 2020) [5].



**Fig 1:** Insect pests infesting various crops, vegetation and stored grains

Weeds are certainly as old as agriculture and from the beginning, farmers recognized that the existence of such unsown species of plant interfered with the growth of the crop they intended to produce. From an agronomic perspective, a weed is any plant that the farmer has not purposefully planted or propagated and that needs to be controlled to prevent it from interfering with the productivity of crops or livestock. Across agriculture systems worldwide, one of the primary obstacles limiting food production is weeds (Monteiro & Santos, 2022) [6]. The weed flora that coexists with crops and exists in uncropped land varies depending on the agroclimatic conditions and is

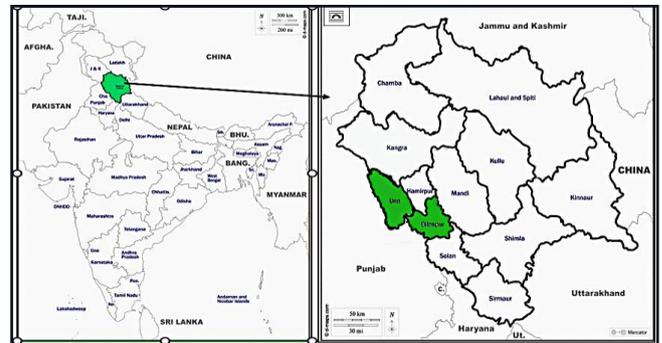
representative of nearly every climate. The term ‘non-cropped land’ refers to any land that is used for purposes other than the production of crops, such as roadsides, rail track sides, waste lands, nallah sides, banks of streams and rivers, woodlands, tea gardens and orchards. The true hazard to ecosystem and health of people as well as animals are the weeds that spread in these areas. Few examples of non-cropped land weeds are *Ageratum houstonianum*, *Lantana camara*, *Parthenium hysterophorus*, *Oxalis latifolia*, etc. The yield of grasses has decreased due to the occurrence of these weeds in pastures (Rana *et al.*, 2015) [8]. Major weeds associated with crops are *Ageratum conyzoides*, *Amaranthus viridis*, *Cyperus compressus*, *Digitaria sanguinalis*, *Euphorbia hirta*, etc. (Badiyala *et al.*, 2015) [2]. Weeds can worsen the effects of other agricultural pests by functioning as hosts, providing shelter and food for herbivores and pathogens of plants. A fundamental aspect of the "weed syndrome" has been suggested to be the weed’s capacity for quick adaptation to new surroundings and human management (Neve *et al.*, 2018) [7]. When weeds employ specific tactics, they can outcompete other plants for scarce resources, which primarily consist of light, water and nutrients. One of these tactics is allelopathy in which secondary chemicals prevent other plants from germinating and growing (Ekwealor *et al.*, 2019) [4]. The most common and effective way to control weeds is to apply herbicides, commonly referred to as chemical substances. Herbicides can lower expenses and labour requirements while increasing crop efficiency and enabling minimal tillage production methods. Herbicide-resistant weed populations may arise as a result of overusing herbicides with the same mechanism of action. Because of this, a few hard-to-control weed species currently dominate agricultural landscapes, offering little resources for farmland biodiversity. Also, herbicides can contaminate ground and surface waters and leave residues in the food chain. Furthermore, chemical herbicides have the potential to significantly lower earthworm and microbial populations in the soil and the long-term consequences of weed suppression may result in a decline in soil biodiversity and nutrient availability (Monteiro & Santos, 2022) [6]. The practice of organic farming holds promises for enhancing food quality, conserving non-renewable resources and safeguarding the environment. Growing agricultural production and stabilising it in a profitable and practical manner are imperative due to the world’s population growth and the diminishing availability of basic resources like food and water. With declining returns, the benefits of green revolution have now plateaued, necessitating the development of alternative methods. Organic and environment friendly farming have become more important in light of the fact that biological as well as crop resources are over-impacted due to the spread of weeds.

**Material and Methods**

**Study Area**

The study was conducted in the Shivalik hills, an ecologically rich region in the Himalayan foothills of Himachal Pradesh (India). In Himachal Pradesh, Shivalik region covers the Bilaspur, Hamirpur, Una and lower part of Kangra, Mandi, Sirmaur, Chamba and Solan districts. This region, known for its diverse landscapes and varying altitudes, supports a wide array of flora and fauna. The region has a combination of subtropical and moderate warm

temperate climates with distinct seasonal variations that influence both the local ecosystem and agricultural practices. The present study focuses on rural areas within the Shivalik foothills, especially in the Bilaspur and Una districts as shown in Fig 2. These regions are home to dense forests, agricultural fields and rural communities providing a unique environment for investigating traditional knowledge systems and their application in sustainable management of resources.



**Fig 2:** Map showing the study area

**Methodology**

The survey was conducted in rural areas belonging to Una and Bilaspur districts of Himachal Pradesh from July 2022 to September, 2024. The study focused on documenting the traditional methods of controlling insect-pests and weeds in cropped and non-cropped areas. Farmers and other informants shared information on local names of plants, substances used, preparation methods and application techniques. Data was collected through structured interviews, group discussions and a prepared questionnaire to gather insights into indigenous practices. Data gathered from people in different age groups was collected through the interview which included demographic information such as name, gender, age, education, occupation and professional experience.

**Table 1:** Demographic characteristics of the informants

Demographic characteristics	Number of informants	Percent (%)
<b>Gender</b>		
Male	41	45%
Female	51	55%
<b>Age Groups</b>		
22-31	6	7%
32-41	15	16%
42-51	10	11%
52-61	25	27%
62-71	26	28%
72-81	7	8%
81 Above	3	3%
<b>Educational level</b>		
Illiterate	18	20%
Primary education	22	24%
Secondary education	20	22%
Higher secondary education	25	27%
Graduation and above	7	7%

The data indicates that a higher proportion of participants were female (55%) compared to male (45%). The majority of informants were older, with a significant number falling

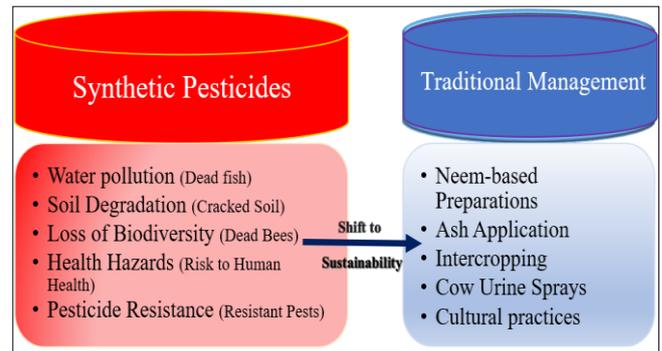
in the 52–71 age range (55%). Educational levels varied with the largest group having higher secondary education (27%), while 20% were illiterate. These findings suggest that the older individuals with diverse educational backgrounds significantly contributed to the data collection (Table 1).

**Results and Discussion**

**Traditional Herbal Practices for Insect-Pest Control**

Traditional herbal practices for insect-pest control are integral to the sustainable agricultural methods employed by local communities. These customs are based on naturally occurring materials that are easily accessible in the environment and have their roots in indigenous knowledge that has been passed down from generation to generation through the decades. One such successful technique is intercropping, in which farmers grow a variety of crops to provide a natural defense against insect infestations. This method not only lowers insect prevalence but also improves soil fertility and crop health in general. Additionally, local farmers utilize simple yet effective pest control techniques such as spreading ash over the fields to deter insects, applying cow’s urine combinations with different plants, utilizing cow’s dung to produce potent natural pesticide and using butter milk (‘lassi’) to attract and trap pests (Fig. 3).

Among these, *Azadirachta indica* (‘neem’) holds a prominent place due to its exceptional insecticidal and repellent qualities (Table 2).



**Fig 3:** Synthetic pesticides vs traditional pest management

These traditional approaches demonstrate the community’s attention to environmentally benign and sustainable farming, being relatively inexpensive and has no negative impacts on the environment. By relying on nature’s resources, these methods not only ensure effective pest control but also contribute to maintain the ecological balance in agricultural landscapes.

**Table 2:** Traditional practices for insect-pest management adopted by the local communities in Bilaspur and Una districts of Himachal Pradesh

Sr. No.	Plant Name	Family	Common Name	Practices for Insect-Pest Control
1.	<i>Albizia procera</i> (Roxb.) Benth.	Fabaceae	Siris	<ul style="list-style-type: none"> <li>Leaf juice is sprayed directly onto the crops as a natural insect repellent.</li> <li>Chopped leaves of the plant are fermented for 10 to 15 days with cow’s urine and jaggery to create a diluted solution which is then sprayed on the crops to efficiently manage pests.</li> </ul>
2.	<i>Allium sativum</i> L.	Amaryllidaceae	Lahsun	<ul style="list-style-type: none"> <li>Dried leaves are added to stored grains for long-term protection against pests, particularly the lesser grain borer (<i>Rhyzopertha dominica</i>) locally called ‘sursi’.</li> <li>Plant is frequently cultivated in the field with other crops in mixed cropping systems to protect the crops and naturally ward off insects.</li> </ul>
3.	<i>Aloe barbadensis</i> Mill.	Asphodelaceae	Gwarpattha	<ul style="list-style-type: none"> <li>Leaves mixed with chili plant residue are kept undisturbed in 10-15 liters of water for 15 days. The mixture is then filtered and sprayed over the infested crops at intervals of 2-3 weeks to effectively repel insects.</li> </ul>
4.	<i>Azadirachta indica</i> A. Juss.	Meliaceae	Nim	<ul style="list-style-type: none"> <li>Fruits and dried leaves of the plant are mixed with cow’s urine and left for 48 to 72 hours. The mixture is filtered and sprayed on the plants as insect repellent.</li> <li>A mixture of leaves, cow’s urine, and garlic is left as such for a certain period. After filtering, the extract is diluted with water for use in agriculture where it successfully suppresses pests.</li> <li>Dried leaves and matchbox sticks are added to wheat grains for long-term preservation, helping to keep insects away and protect the stored grains.</li> </ul>
5.	<i>Calotropis procera</i> (Aiton) W.T. Aiton	Apocynaceae	Aak	<ul style="list-style-type: none"> <li>The plant is grown along the field borders by farmers to prevent insect infestations.</li> <li>Dried leaves are mixed with dried datura leaves, jaggery and cow’s dung. This mixture is spread in the field by farmers to prevent insects and caterpillar infestations.</li> </ul>
6.	<i>Carica papaya</i> L.	Caricaceae	Papita	<ul style="list-style-type: none"> <li>Leaves are pulverized along with pomegranate leaves and kept in water for whole day. This solution is sprayed over vegetables and crop fields to prevent pest attack.</li> </ul>
7.	<i>Coriandrum sativum</i> L.	Apiaceae	Dhaniya	<ul style="list-style-type: none"> <li>Plant is generally used in mixed cropping systems by farmers for natural pest control.</li> </ul>
8.	<i>Eucalyptus tereticornis</i> Sm.	Myrtaceae	Safeda	<ul style="list-style-type: none"> <li>Extract prepared by mixing large amount of leaves with residues of lemon (<i>Citrus limon</i>), mint (<i>Mentha spicata</i>) and oleander (<i>Nerium oleander</i>) in water is sprayed in the fields to prevent grasshopper’s infestation.</li> </ul>

9.	<i>Ipomoea carnea</i> Jacq.	Convolvulaceae	Basuti	<ul style="list-style-type: none"> <li>Leaves are crushed along with chili, garlic, leaves of neem and mixed with cow's urine. This mixture is used by local people for pest control.</li> <li>It is planted along the field boundaries to protect the fields from the attack of insects.</li> </ul>
10.	<i>Justicia adhatoda</i> L.	Acanthaceae	Adusa	<ul style="list-style-type: none"> <li>Plant residue is pulverized, mixed in water and sprayed over the field to control pests.</li> </ul>
11.	<i>Raphanus sativus</i> L.	Brassicaceae	Muli	<ul style="list-style-type: none"> <li>Plant is generally used in mixed cropping systems by farmers for natural pest control.</li> </ul>
12.	<i>Ricinus communis</i> L.	Euphorbiaceae	Arand	<ul style="list-style-type: none"> <li>Powdered leaves are mixed with water, green chili pulp, cow urine, and cow dung. This mixture is left undisturbed for some time, filtered and the extract obtained is used as an insecticidal spray.</li> </ul>
13.	<i>Anethum graveolens</i> L.	Apiaceae	Dill	<ul style="list-style-type: none"> <li>It is grown as mixed crop typically alongside crops such as wheat, barley and legume crops helping to manage pests and enhance soil fertility.</li> </ul>
14.	<i>Tinospora cordifolia</i> (Willd.) Hook.f. & Thomson	Menispermaceae	Giloy	<ul style="list-style-type: none"> <li>Extract obtained by the fermentation of stem is mixed with cow's dung and jaggery. This mixture is sprayed over the crops to prevent the attack of insect-pests.</li> </ul>
15.	<i>Vitex negundo</i> L.	Lamiaceae	Neergundi	<ul style="list-style-type: none"> <li>Leaves of the plant are kept in water with the leaves of neem plant and jaggery for one month, then strained and used as a natural insecticide for crop protection.</li> </ul>

### Traditional Herbal Practices for Weed Management

A variety of environment friendly weed control techniques have been employed in Bilaspur and Una districts of Himachal Pradesh which are based on local population's traditional knowledge. To naturally inhibit weed growth, farmers use traditional methods including mulching with organic materials, using cover crops and using different planting strategies. These areas frequently employ manual methods, such as physical removal of weeds and use of basic tools. To manage weed infestations, particular bio-based treatments are also used such as natural blends made from plant leaves, fermented organic materials and locally accessible resources. These approaches provide important support for contemporary sustainable farming since they prioritize sustainability, economy and incorporation of traditional ecological knowledge into agricultural techniques.

### Common Weed Management Practices in Bilaspur and Una Districts of Himachal Pradesh

- Mulching:** It is the practice of covering soil surface with a layer of material. In Una and Bilaspur region, organic and inorganic materials are used.

**Dry Mulch:** This method involves using dried plant components as a natural weedicide. For example, the leaves of *Syzygium cumini* (black plum) and *Pinus roxburghii* (pine tree) needles are spread over the soil to prevent weed growth. This technique is commonly used in the cultivation of crops such as *Zingiber officinale* (ginger), *Colocasia esculenta* (taro) and *Curcuma longa* (turmeric), where the mulch acts as a barrier, suppressing weeds and retaining moisture in the soil.

**Live Mulch:** In this approach, cover crops are planted to suppress weed growth. *Vigna unguiculata* (Cowpea) is often grown as a cover crop in maize fields. The cowpea plants help shade the soil, preventing weeds from establishing and competing with the main crops for nutrients and water. This method not only controls weeds but also improves soil fertility by adding organic matter.

- Mixed-Cropping:** This practice involves growing multiple crops together in the same field to reduce the space available for weeds by local inhabitants. By planting complementary crops such as coriander

alongside onions, the dense canopy formed by the plants helps to shade the soil, preventing weed growth. Mixed-cropping not only suppresses weeds but also enhances biodiversity, improves soil health and reduces the risk of pest infestations. Mixed cropping of *Allium sativum* (garlic), *Anethum graveolens* (dill), *Coriandrum sativum* (coriander), and *Raphanus sativus* (radish) is a sustainable farming practice that promotes weed suppression and enhances farm diversification.

- Hand-Pulling:** This method involves the manual removal of weeds from cropped land. Weeds like *Medicago polymorpha* (bur clover) in wheat fields are physically pulled out by hand to prevent them from competing with crops for nutrients, water and sunlight. Hand-pulling is an effective, though labour-intensive, way to manage weeds especially in small-scale farming or areas where chemical herbicides are avoided. Hand pulling method is mainly employed in rice fields as well as vegetable grown fields to remove weeds like *Echinochloa crus-galli*, *portulaca oleracea*, *Chenopodium album*.
- Crop Rotation:** This practice involves changing the type of crops planted in a particular field from one season to the next. By alternating crops, farmers can disrupt the growth cycles of weeds, as different crops have varying growth patterns and root systems. This reduces the chances of weeds becoming established and multiplying, ultimately leading to better soil health and reduced weed pressure over time. Planting of maize and then mustard as well as rice and then wheat are the common practices of crop rotation in the region for disrupting weed cycle and maintaining the soil health.
- Hand-Hoe:** This method involves using manual tools such as spades, forks or rakes to remove weeds from cropland. The tools are used to uproot or cut weeds at the soil surface, preventing them from regrowing. It is an efficient way to control weeds in small-scale farming or areas where chemical herbicides are not preferred. Hand-hoeing also helps in loosening the soil, promoting better aeration and water absorption for crops. For example, *Achyranthes aspera* and *Cyperus rotundus* can be effectively controlled using a hand hoe.

- **Mowing (via Sickle):** This method involves the use of sickle to cut and remove weeds from non-cropped areas such as fallow land, roadsides or field borders. Mowing helps to control the spread of weeds by cutting them before they can flower and produce seeds. This technique is effective in preventing weed infestations and reducing competition for nutrients and space, especially in areas where other forms of weed management may not be feasible. Mowing practices using a sickle are commonly employed in maize fields to control weeds like *Medicago polymorpha*, *Cynodon dactylon* and *Setaria viridis*. Weeds, after cutting, are often used as fodder.

### Specific Weed Management Practices for Cropped Land in Una District

1. **Utilizing Cow Urine as an Organic Weedicide:** Cow urine is used as a natural weedicide by diluting it with water (typically 1 part urine to 4 parts water) and spraying it on land which is to be used for future cultivation. This organic solution is believed to suppress weed growth and is a part of traditional agricultural practices in certain regions. The chemical properties of cow urine are thought to inhibit the germination and growth of weeds, while being environment friendly and safe for other crops.
2. **Herbal Weedicide Mixture**
  - **Ingredients:** Datura leaves, Neem leaves, and Cow urine.
  - **Process:** The leaves of *Datura stramonium* (Datura) and *Azadirachta indica* (Neem) are mixed with cow urine and left to steep for 5-6 hours. After steeping, the mixture is diluted with water (1part mixture to 3 parts water) before being sprayed on cropped lands. This natural concoction is believed to have strong herbicidal properties, helping to control weeds without harming the environment or the crops. The potent compounds in Datura and Neem along with the beneficial properties of cow urine, work together to suppress weed growth.
3. **Citrus-Vinegar Mixture**
  - **Ingredients: Orange peel, vinegar and water**
  - **Process:** The orange peel and vinegar are mixed and allowed to steep for 7-8 hours. After this, the mixture is sprayed on cropped areas to control weed growth. The acidity of vinegar combined with the natural oils from the orange peel creates an effective organic solution that helps to suppress weeds while being safe for the environment.

### Specific Weed Management Practices for Cropped Land in Bilaspur District

1. **Sour Buttermilk Weedicide**
  - **Preparation:** 5-6 days old sour buttermilk ('Lassi') is diluted with water.
  - **Application:** The mixture is sprayed over the cropped land. The sourness of the buttermilk, combined with its natural microbial content, acts as an effective organic weedicide, helping to control weed growth without harming the crops.

### 2. Leaf-Based Herbal Mixture

- **Ingredients:** Castor leaves, Papaya leaves, Mango leaves, and Cowpea leaves.
- **Process:** The leaves of *Ricinus communis* (Castor plant), *Carica papaya* (Papaya), *Mangifera indica* (Mango) and *Vigna unguiculata* (Cowpea) are boiled together. After boiling, the mixture is cooled and then used in small amounts, diluted with water before application.
- **Application:** The diluted solution is sprayed on cropped lands to control weed growth. This natural herbicide helps in suppressing unwanted weeds in agricultural fields.

These traditional weed management practices reflect a profound understanding of indigenous communities pertaining to the local ecology and resource utilization, demonstrating how traditional knowledge can contribute to sustainable agricultural practices. By integrating local plants and natural materials into farming techniques, communities have developed efficient, environmental friendly solutions to manage weeds (Fig.4) This approach not only preserves biodiversity but also minimizes the reliance on chemical inputs, fostering a more resilient and ecologically balanced agricultural system. The potential for combining these traditional methods with modern agricultural practices can enhance sustainability and promote long-term environmental health.

### Weed Management Approaches for Non-Cropped Lands

To reduce the ecological and economic impacts of weeds in uncropped regions, a mix of mechanical, chemical, biological and preventative methods must be used. The main goals of prevention strategies include raising public awareness, making sure that land is used properly to stop the spread of invasive species and planting competitive vegetation to stop the growth of weeds. Mechanical techniques including uprooting, chopping, and controlled burning work well for quick eradication but need to be maintained often to stop regrowth. Chemical control is the careful use of pesticides to target certain weeds and minimize their dominance. To reduce damage to the environment and prevent herbicide resistance, this approach has to be well controlled. To sustainably lower weed populations, biological management techniques need to be encouraged using natural enemies like insects, diseases or rival plants. Integrated weed control tactics that combine these methods are crucial for long-term management because they guarantee efficient suppression while preserving ecological balance in non-cropped areas (Angiras, 2014) <sup>[1]</sup>.

Indigenous communities in the study area have developed a range of traditional practices to manage weeds in non-cropped environments, focusing on manual and community-based methods (Fig. 4). For instance, to control *Ageratum* species which are prevalent in Himachal Pradesh, communities often engage in manual removal, particularly after rains when the soil is wet, making it easier to uproot. This practice is typically carried out on a community basis during the rainy season. In some cases, regular field campaigns to remove the weeds before seed-setting are employed to prevent further spread. Similar methods are also used for invasive species like *Lantana camara*. Despite

toxicity of *Lantana camara*, indigenous groups have discovered a number of ways to exploit its benefits while reducing its negative consequences. On steep slopes, *Lantana* is used to conserve soil by preventing erosion and restoring soil fertility. By using its twigs for mulching, composting and even as fuel, small communities can gradually lower its population density when many individuals participate in this approach. Its biomass has also been used to inhibit other weeds. *Parthenium hysterophorus*

is often manually removed by communities through hand pulling, hand hoe, mowing practices to control its spread. This practice is conducted before the flowering season to prevent the plant from producing seeds and spread further. Generally, local people spread 5-6 days old sour buttermilk over uncropped lands to control weeds such as *Ageratum conyzoides*, *Parthenium hysterophorus*, *Chromolaena adorta* and *Biden pilosa* by targeting them near their surroundings.



**Fig 4:** Traditional Insect-Pest and Weed Management Practices Used by Local Communities

The study highlights the traditional weed management practices such as dry mulch and live mulch which suppress weed growth. Mixed-cropping and crop rotation help to minimize available space for weeds and disrupt their growth cycles. Physical methods like hand-pulling and using tools (spades, forks) are also commonly employed. Sour buttermilk is used to prevent weed growth in cropped and non-cropped lands. For managing non-cropped weeds, manual removal and community efforts are utilized by native people and also weeds are used for other innovative purposes. These practices demonstrate a deep understanding of local communities regarding sustainable agriculture and conservation of biological resources

### Conclusion

Traditional pest and weed management practices in the study area reflect harmonious amalgamation of indigenous knowledge and ecological stability. Conventional pest management techniques, such as using plant-based extracts and other locally accessible resources, provide effective and environment friendly pest control solutions. In cropped land, practices such as hand weeding, crop rotation, mixed cropping and mulching have proven effective in maintaining soil fertility and reducing weed invasion without relying on synthetic chemicals. Non-cropped lands benefit from

controlled burning and manual uprooting which help to maintain ecological balance and prevent the proliferation of invasive species. These time-tested practices not only safeguard biodiversity but also promote sustainable livelihoods for the local farming communities. In contrast, synthetic weedicides and pesticides offer a faster and more effective approach to control weeds and pests, particularly in large-scale agricultural settings. However, it poses significant environmental and health risks including soil degradation, water contamination and harm to non-target organisms. Additionally, the overuse of herbicides and pesticides can lead to the development of herbicide-resistant weed species as well as pesticide resistance. Therefore, integrating traditional methods with modern techniques can provide a holistic approach to insect-pest and weed management.

### Acknowledgement

The financial support granted by the Council of Scientific and Industrial Research (CSIR), New Delhi to Ms Divya, Department of Bio-Sciences, H.P. University, Shimla (Award No.: 09/237(13332)/2022-EMR-1) under CSIR-NET Senior Research Fellowship (SRF) is highly acknowledged.

### References

1. Angiras NN. Management of perennial weeds under non-cropland hill ecosystems. *Indian Journal of Weed Science*,2014;46(1):52–60.
2. Badiyala D, Rana SS, Sharma N, Kumar R. Major weeds in cropped lands of Himachal Pradesh. Department of Agronomy, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur, 2015. <https://www.researchgate.net/publication/323118437>
3. Dougoud J, Toepfer S, Bateman M, Jenner WH. Efficacy of homemade botanical insecticides based on traditional knowledge. A review. *Agronomy for Sustainable Development*,2019;39(4):1-22. <https://doi.org/10.1007/s13593-019-0583-1>
4. Ekwealor KU, Echereme CB, Ofobeze TN, Okereke CN. Economic importance of weeds: A review. *Asian Plant Research Journal*,2019;3(2):1-11. <https://doi.org/10.9734/aprj/2019/v3i230063>
5. Lengai GM, Muthomi JW, Mbega ER. Phytochemical activity and role of botanical pesticides in pest management for sustainable agricultural crop production. *Scientific African*,2020;7:e00239. <https://doi.org/10.1016/j.sciaf.2019.e00239>
6. Monteiro A, Santos S. Sustainable approach to weed management: The role of precision weed management. *Agronomy*, 2022, 12(1). <https://doi.org/10.3390/agronomy12010118>
7. Neve P, Barney JN, Buckley Y, Cousens RD, Graham S *et al.* Reviewing research priorities in weed ecology, evolution and management: a horizon scan. *Weed Research*,2018;58(4):250-258. <https://doi.org/10.1111/wre.12304>
8. Rana SS, Badiyala D, Sharma N, Kumar R. Major weeds in the non-cropped lands of Himachal Pradesh. Department of Agronomy, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur, 2015. <https://www.researchgate.net/publication/323114838>