

INVASIVE WEEDS A THREAT TO THE BIODIVERSITY: A CASE STUDY FROM ABBOTABAD DISTRICT, N-W PAKISTAN*

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ABSTRACT

A survey was conducted using a sample of 200 farmers from 16 villages of Abbotabad district, during August 2001 to March 2002 regarding weeds. A total of 36 weeds were reported as problem weeds, and out of that, only 16 weeds reported as invasive. These were *Xanthium strumarium*, *Ipomoea eriocarpa*, *Alternanthera pungens*, *Trianthema portulacastrum*, *Tugetes minuta*, *Imperata cylindrica*, *Amaranthus hybridus*, *Robinia pseudoacacia*, *Broussonetia papyrifera*, *Ailanthus altissima*, *Pistia stratiotes*, *Phragmites australis*, *Parthenium hysterophorus*, *Cannabis sativa*, *Galium aparine* and *Emex spinosus*. Among these invasive plants, *Robinia pseudoacacia*, *Broussonetia papyrifera* and *Ailanthus altissima*, were purposely introduced and all three are trees and they later on became invasive or at least aggressive by replacing or suppressing the local vegetation. Their distribution, history of invasion and management has been discussed in this manuscript.

Key Words: Invasive weeds, Indigenous knowledge, Biodiversity

INTRODUCTION

Natural selection resulted in plants that were adapted to unstable or disturbed areas in a wide array of environments. As a consequence native plants evolved through several stages of succession, spread over thousands of years to fill the ecological niches. Native plants are responsible for the basic biological matrix of all communities, and their growth form determines the community structure (Krebs, 1994). When man first started to deliberately grow plants for food, the concept of weeds as unwanted plants, reducing crop yield through competition was born. Many present day weeds (being alien and invasive) did not exist in the wilderness some years back. Weed infestation took on new vigor as technological advances prevailed, including urbanization, extensive trade, migration, reclamation and settlement of new lands, growing of useful plants and developments of livestock industry etc. Different invaders either brought such weeds inadvertently or through seed import. Moreover some ecological disturbances like disease, fire and cleaning of land etc. made changes at micro- and macro- level, opened up niches for new alien and invasive weeds. According to Marwat (1984) a total of 284 weeds were reported from NWFP, but some of the important weeds like, *Phragmites australis*, for example was not a problem weed at that time, which was reported later on (Marwat, 1993): which suggest that weeds can change their habit and become aggressive for certain reasons.

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The term invasive species refers to those species, which establish themselves in an area outside their natural range, exponentially increasing their population, thus out-competing the native species of that area and usually bringing changes in the function of ecosystem. Ecologically each species occupies a niche in the eco-system. According to Gause's competitive exclusion principle, the two species occupying the same niche cannot survive simultaneously forever. The more aggressive one thrives and the poor competitor vanishes. In order for the two species to co-exist they should have separate niche requirements (Radosevich & Holt, 1984). Thus in the above definition of invasive species whereby they establish in new habitat away from their natural habitat, their establishment is encouraged due to the lack of concerned predators and parasites there in the new environment. Thereby in the absence of their natural enemies, some of the alien plants became invasive, affecting the biodiversity of our natural ecosystem, disturbing the ecological balance in the new habitat. Invasive species have altered bio-diversity, caused economic loss and risk to human health. Invasive weedy species cannot protect the soil, the way native plants do, thus erosion increases, which can affect the composition of our local flora & fauna (biodiversity), while some are choking water streams, thus affecting fish population and water quality. Such plants are aggressive and monopolize resources and push out native plants, including the endangered ones (Cheater, 1992). Keeping in view the impact of invasive weeds on environment, article 8(h) of the Convention on Biological Diversity (CBD) signed by 161 countries at the Earth Summit in 1992 urges the parties to "prevent the introduction of, control, or eradicate those alien species which threaten ecosystem, habitat or species" (Hussain *et al.*, 2000) and Pakistan being a member of CBD, has to play its role judiciously.

The research base in the country is very weak on this subject. Only sporadic studies have been undertaken in the past in other parts of the world (Holm *et al.*, 1977). The meager studies so far undertaken list 700 and 4500 species of vascular plants as alien and indigenous species, respectively (Khatoun & Ali, The Herald annual, January 1999 after Hussain *et al.*, 2000). According to this report, of these 700 alien species 5 or 6 could be recognized as high-impact invasive. These include 'Paper mulberry' (*Broussonetia papyrifera*), 'Mesquite' (*Prosopis juliflora*), 'Water hyacinth' (*Eichhornia crassipes*), and 'Congress grass', (*Parthenium hysterophorus*). Out of these species some of the alien invasive plants species, like, *Broussonetia papyrifera* are not only reducing the land value and causing economic loss to agriculture Communities, but are also source of allergy and related health problems in Islamabad & Peshawar. Similarly the name *Parthenium* as allergen producing species frequently comes in the national print media (Khalid, 2002). The infestation of the water bodies by *Eichhornia* and *Salvinia* has not been highlighted despite its economic importance. Similarly, the harms of *Prosopis juliflora* could be witnessed in the railway tracks and linear plantations on roads as well as in the irrigated forests and many a waste lands. *Eucalyptus* is another example highlighting the invasive behavior in farm forestry due to its aggressiveness and release of allelo-chemicals into the environment (Hussain *et al.*, 2000). *Xanthium strumarium* and *Phragmites australis* are also considered as new emerging weeds, which have invaded areas out of their natural habitat (Marwat 1993).

In certain cases, when weed infestations like other disturbances, goes beyond a certain threshold, become severe and widespread; communities are totally changed, thus, restoration of original vegetation often becomes either impractical or impossible with today's technology and economics. The invasion is recognized only after it has entered an explosive phase. Unfortunately, by this stage, it is difficult or impossibly expensive to control the increase of the invader (Huenneke, 1996; Randall, 1996).

Keeping the above scenario into consideration, this study was carried out in collaboration with WWF-Pakistan with the objectives to make an inventory of invasive species, document history of invasion, suggest control measures and to use the indigenous knowledge of the local communities to cope with the problem of invasive weeds.

METHODOLOGY

Ethnobotanical approach, using indigenous knowledge of the local communities was employed in study of invasive weeds. For this purpose, survey method was used to determine the extent of invasive weeds.

The questionnaire was pre-tested in hilly areas, viz., Nathiagali, Gora Gali, Baragali, Mochi Dara, Pasala and Tandiani. None of the farmers in those areas responded to invasive weeds' issues, therefore, the questionnaire was once again modified and pretested in plains including agricultural lands. This time the response was explicit therefore questionnaire was finalized and a sample of 200 farmers was randomly selected as respondents from 16 villages, 6 near Abbotabad, 3 around Haripur, 2 near Havelian, 3 on the way from Haripur to Khanpur Dam and 2 near Tarbela/Ghazi. These farmers were interviewed during August 2001 to March 2002; a period spread over 8 months using the questionnaire. During the survey personal observations were also recorded regarding the different weeds. The data obtained from these questionnaires and personal observations is presented and discussed accordingly.

RESULTS AND DISCUSSION

The present study was of field survey nature; therefore the information gathered cannot address the practical aspect of invasive weeds. Since invasiveness does involve sowing and establishment of suspected species on bare land as well as in established plant communities, to compare biology and ecology which is beyond the scope of this study. Therefore, reliance has been made on data obtained from questionnaires as well as field observations. It is also interesting to note that invasive species were only reported from disturbed sites, mainly agricultural land. Some of the plants for example *Broussonetia papyrifera*, *Ailanthus altissima*, *Robinia pseudoacacia*, and *Cannabis sativa* were from roadside areas, which were again disturbed. Though the plantation of *Broussonetia* was not supported by evidence during the survey, but the later ones (*Ailanthus* and *Robinia*) were planted through campaign of forest department. The survey was conducted in several phases to cover the different seasons and in the pre-testing, only agricultural land has a promise of invasive weeds therefore majority of the visit were made to farmers' field in different areas.

Plants which invade an established plant community and interfere with the biodiversity, have usually prolific reproduction, wide adoptability and can escape common control measures are considered invasive. As already indicated, invasiveness cannot be established through such a study, thus basically the weeds mentioned in this study are mainly aggressive and then through indirect evidences, some of the weeds as listed in Table-1 can be classified as invasive, although the typical definition which covers the alien ones may not be true in this case, as all the weeds which are invasive may be or may not be alien. For example *Xanthium* and *Pistia* are not alien (Stewart, 1972) but they have become invasive in the recent past. The evolutionary changes might have modified the genotypes resulting in more suitable ecotypes for these habitats.

As shown in Table 1, farmers reported a total of 16 weeds as invasive, found in crops, Wastelands, Roadside, Orchards, etc. Botanical description, distribution and detailed comments regarding behavior of these invasive plants are discussed as follow.

1. XANTHIUM STRUMARIUM L. (Family Asteraceae) Sp. Pl. 987, 1753; Stewart, Ann. Cat. Vas. Fl. Pak. & Kash. 801, 1972. Common name: Common cocklebur, Gihra Kunda.

Distribution and habitat: From plains upto 2500m in the northern parts of the province. In Abbottabad, this is becoming very dangerous and it may spread in other areas too. In Sheikhul Bandi and Nawashahr area of Abbottabad, it covers the fields in such a way that no plant can compete with it. Flowers June to October.

History of Invasion: It is ubiquitous weed and has been introduced in early 1980's in Abbotabad found in maize fields and wastelands. The patches of *Xanthium strumarium* along the roadside and people's response suggest that it's spiny fruit clinging to the wool of sheep, goats has been the major force of its spread. The nomad Afghans used to bring sheep herds in winter from Afghanistan and they had to make stay along the roadside throughout the N-West part of Pakistan, which resulted in small to large patches of aggressive weeds which ultimately escaped to cultivated fields with the passage of time. Since cattle do not feed on this weed, neither it has fuel importance; therefore it remains unchecked and thus replaces the native plants accordingly. Its present importance value suggests that it is going to be one of most noxious weed of crop lands (Marwat, 1993) as is the case in US (Marwat & Nafziger, 1990).

Management: Since this weed is not of a problem in crops, therefore, mechanical control is recommended, but at places where it has replaced the total vegetation, then non-selective herbicides (Table-2) are recommended for its effective control. In certain cases it is a weed of maize, therefore, maize herbicides can be affectively used for its control (Table-2). Certain biological agents have also been tried for its management successfully (Julien, 1992).

2. IPOMOEA ERIOCARPA R. Br., (Family Convolvulaceae) Prodr. 484, 1810; Austin and Ghazanfar in Nasir and Ali's F. Pak. 126: 41-43, 1979. (Syn. *Convolvulus hispidus* Vahl., *I. hispida* (Vahl) Roem. & Schultes). Common name: Ilra (local).

Distribution and habitat: Found as weed of maize fields in Hazara, from tropical Africa and Madagascar through Indo-Pak to N. Australia. Fl. per. August - October.

History of Invasion: This seems an old native plant of the area and cannot be considered as invasive per se, but for sure its frequency and density has been increasing as the farmers have suggested. Field observations also suggest its aggressiveness, but are restricted ecologically to a limited area.

Management: Since it is a major weed of maize, therefore maize herbicides can be used effectively against such weed (Table-2). As it spreads through farmyard manure (FYM), therefore, in long term integrated weed management, including composting of FYM, crop rotation and mechanical control would be more promising.

3. ALTERNANTHERA PUNGENS Kunth (Family Amaranthaceae) in H.N.K., Nov. Gen. Sp.2: 206, 1817; Stewart, Ann. Cat. Vasc. Fl.W. Pakistan. 229, 1972. (Syn: *Achyranthes repens* L., *Alternanthera achyrantha* (L.) Sweet; *Alternanthera repens* (L.) Link.) Common name: It-sit (farmers confuse it with *Trianthema portulacastrum*).

Distribution and habitat: Hazara: Abbottabad, roadside Peshawar. Common weed of wasteland and vegetables.

History of Invasion: A native of tropical America, now widespread as a weed of waste ground etc. in the tropics and subtropics of both Old and New Worlds. Seems to thrive in bare, heavily trodden places.

Management: Since it is a weed of vegetables mainly, therefore, mechanical control as is a general practice helps its management. However, for more effective management, it should be supplemented with herbicides registered for vegetables (Table-2).

4. *TRIANTHEMA PORTULACASTRUM* L., (Family Aizoaceae) Sp. Pl. 223. 1753; Nasir in Fl. W. Pak. 41: 3. 1973. (Syn. *T. obtordata* Roxb; *T. monogyna* L.). Common name: Urdu: Wisak; Pushto: Insat, It-sit.

Distribution and habitat: Common weed of maize fields in Hazara, Swat, very common in the surroundings of Haripur city as a weed of maize and vegetable fields. Tropical America, Africa, W. Asia, Ceylon, India and Pakistan. Fl. per. May -November.

History of Invasion: A common weed of kharif season throughout the country. Since there has been recent trend towards growing vegetables, therefore, continuous vegetable sowing for several years on the same field has given it a chance to become more aggressive than ever before.

Management: Since it is a weed of maize & vegetables, therefore, clean vegetable seed, crop rotation and mechanical weed control integrated with herbicides registered for these crops can reduce its population effectively; in non-crop situation, the non-selective herbicides (Table-2) can be used for its control.

5. *TAGETES MINUTA* L. (Family Asteraceae) Sp. Pl. 887. 1753. Stewart, Ann. Cat. Vas. Fl. Pak. & Kash. 785. 1972. Common name: Gul-e-Sadbag (local); Mexican marigold.

Distribution and habitat: Very common in Swat and Hazara districts of NWFP. It is mostly found in wastelands but also invades maize fields as well.

History of Invasion: Apparently seems to be an escape from cultivation. But during the past about 10 years, its population has been increased tremendously and is a major threat to our local vegetation in those areas.

Management: A weed of maize & wastelands can be managed through composting of FYM, while applying to the field, while simultaneously crop rotation and mechanical control can play a major role in its management. In severe cases, non-selective herbicides and maize herbicides can be used in non crop and maize field (Table-2), respectively.

6. *IMPERATA CYLINDRICA* (L) Raeschel, (Family Poaceae) No., Bot., ed. 3, 10. 1797; Cope in Fl. Pak. 143: 252: 1982. (Syn. *Lagurus cylindricus* L., *Saccharum cylindricum* (L) Lam. *I. arundinacea* Cyr.). Common name: Engl. Sword-grass, Blady grass.

Distribution and habitat: Found mainly in orchards and wastelands throughout the province - It is a dangerous weed, as its rhizomes are tenacious and if a fragment of its rhizome is left, a new plant can regenerate - Pakistan, throughout the old world tropics, extending to the Mediterranean and the Middle East.

History of invasion: Not known, but seems an old introduction.

Management: Since it is major weed of orchards, therefore, intercropping of legumes, like barseem, guar and alfalfa would be the best way for controlling such weed. In situations, where, intercropping is not possible then, glyphosate or any other nonselective herbicide, using shielded sprayer can be used for its selective control.

7. *AMARANTHUS HYBRIDUS* L., (Family Amaranthaceae) Sp. Pl. ed. 1: 990. 1753; Townsend in Fl. W. Pak. 71: 11-12. 1974. (Syn. *A. chlorostachys* Willd). Common name: Eng: Prince of wales, Hindko: Chalwera.

Distribution and habitat: Weed of cornfields throughout the province; less represented in the southern districts -- A spontaneous naturalized weed in the warmer regions of the world; frequent in temperate regions as well.

History of invasion: Weed of new as well as old world. Birds, FYM and wind seem to have played major role in its dispersal.

Management: Composting of FYM and crop rotation can reduce the weed problem to a great extent. Where these interventions are not possible, then maize & vegetable herbicides (Table-2) integrated with other methods can be used effectively for its management.

8. *ROBINIA PSEUDOACACIA* Linn., (Family Papilionaceae) Sp. Pl. 722. 1753; Stewart, Ann. Cat. Vas. Fl. Pak. & Kash. 419. 1972.

Distribution and habitat: Native of US, cultivated and more or less naturalized in Europe. Cultivated as an ornamental tree in Punjab (Ali, 1977), from plains to 10000 ft (Stewart, 1972).

History of invasion: Forest department planted this tree as a source of firewood along the roadside in Abbotabad district.

Management: Since it is a roadside tree, therefore, the best way would be to control it mechanically which can be supplemented with injecting glyphosate through injectors in the trunks of big trees. Simultaneously, other local trees should be planted simultaneously to fill the microhabitat after cutting these trees.

9. *BROUSSONETIA PAPYRIFERA* Vent. (Family Moraceae). Tabl. Veg. 3: 547. 1794. FBI 5: 490. Stewart, Ann. Cat. Vas. Fl. Pak. & Kash. 191. 1972. Common name: Paper mulberry. Gul toot.

Distribution and habitat: A native of South East Asia. It is distributed from Lahore to Peshawar valley through Salt range, but worst affected are the federal capital Islamiabad, parts of Rāwalpindi and campus of Peshawar University, Peshawar. The introduction of this species in subcontinent is more than 100 years old. According to Parker (1956) it was first introduced in 1880 at Saharanpur and until 1924 it has spread up to Lahore along irrigation channels and into Shahdra Plantation. Parker at that time predicted that this tree would become common in the sub Himalayan tract as well as in the more heavily irrigated portions of the plains especially the places where any prior vegetation was scant (Hussain et al. 2000).

History of invasion: Paper mulberry is the most problematic invasive in northern Pakistan. It has the typical features of invasiveness by fast growth rate, seed dispersal through birds, and ability to vegetative propagation. Its fruits are relished by crows and other birds who thus acts as the vector for its seed dispersal; therefore both crows and paper Mulberry are promoting each other. The increased population of crows has become a nuisance for the residents of

affected areas. It was introduced in Islamabad to make capital green. In less than thirty years period it became a highly invasive species in the natural ecosystem of Himalayan foothills. Around Rawal Lake it has replaced the entire natural vegetation. Margalla Hills is National Park representing good examples of Himalayan foothill vegetation. This invasive species is a growing threat to the natural vegetation of National park and other valleys in the East of Islamabad up to south Azad Jammu and Kashmir. Besides threatening the natural vegetation, it is also a human-health hazard. In a report of Pakistan Medical Research Council (1995), about 45.5% of allergic patients in Islamabad and Rawalpindi showed positive sensitivity to the pollen of *B. papyrifera*. The newly sprouting shoots from trees stumps and ground covers are being cut and burnt. First phase of this operation in Islamabad started from Faisal Avenue and the trees are being replaced with better timber trees. This operation started in 1992 but is not effective as it continues to stage a comeback due to its invasive nature.

Management: There are several ways to cope with this noxious tree, through eradication of its male plant, which would stop pollinating the female one, thus new addition of saplings through seed would stop. Mechanical cutting of the trees associated with application of non selective herbicide, like glyphosate (Table-2) as spray in case small plants and through injectors in case of big trees.

10. AILANTHUS ALTISSIMA (Mill) Swingle, (Family Simarubaceae) Jour. Wash. Acad. Sci. 6: 495. 1916. Stewart, Ann. Cat. Vas. Fl. Pak. & Kash. 440. 1972

Distribution and habitat: Baluchistan, Malakand, Gilgit; Hazzara; Abbotabad; Nathiagalli; According to Stewart (1972) it is cultivated in the hills but does not do well below 5000 ft. However, this tree has been found doing well in lower altitudes as well.

History of invasion: Forest department planted this tree as a source of firewood along the roadside in Swat & Hazara. But now it has invaded the wasteland because of its prolific reproduction and has replaced the local vegetation.

Management: The management recommended for *Robinia pseudoacacia* can work here.

11. PISTIA STRATIOTES L. (Family Araceae). Sp. Pl. 963. 1753. FBI 6: 496; Stewart, Ann. Cat. Vas. Fl. Pak. & Kash. 35. 1972. **Common name:** Water cabbage; Jal kumbi

Distribution and habitat: It is an aquatic plant, weed of stagnant water, can be more of a problem in rice in the future. It is widely distributed in Pakistan and found in water reservoirs, ponds and marches along the edges lakes where they are able to thrive amidst the offshore vegetation and debris, in slow moving or stagnant waters and in old wells. The weed disrupts navigation, plug grills at hydroelectric plants and interferes with fisheries by creating physical barriers and lowering the oxygen content and pH of the water. The species seriously interferes with rice crops through transpiration of water. Plants can float into paddy crop, take roots in the soil and competes with crop under shallow water conditions of the field (Hussain et al 2000).

The plant serves as a preferred host for mosquitoes, vectors of malaria, encephalomyelitis and rural filariasis. The Anopheles mosquito, which carries the parasite responsible for malaria, is frequently associated with *P. stratiotes* because the hydrophytes provide suitable shelter and breeding sites (Holm et al. 1977). In Pakistan this species in ponds and reservoirs has been shown to cause the decay of native hydrophytes. It is not a big problem at this point in Abbotabad district, but if it reaches the rice growing area of Mansehra, then it is going to cause great loss to the rice farmers.

History of invasion: Not known, but according to Stewart (1973), it was reported from Rawal Pindi, West Punjab, but now it is found all around the country upto 2800m altitude.

Management: Similar to other perennial weed of rice, therefore introduction of crop rotation, ploughing and using herbicides (Table-2) can effectively control the weed.

12. *PIRAGMILIS AUSTRALIS* (Cav.) Trin. ex Steud. (Family: Poaceae) New Bot. ed. 17: 424-431; Clayton in Kew Bull. 21: 113, 1967; Bor in Lowry, Ernst & Al-Rawi in Paq. 9: 374, 1968; Clayton in Loxon 17: 168, 1968; Bor in Rech.f. Fl. Iran 1: 387, 1977; Kiselev, Botanic URSS 96: 176; Lam in Lam et al. Fl. Iran 5: 28, 1981; Kishinoue, Com. on Det. Rice, Nat.

Distribution and habitat: Pakistan (Punjab & Kashmir), temperate, subtropical and semiarid, in the G. W. and the New. It is found in lowland, sloping, open, grassy, hilly, and in stream banks, ditches, and ponds, and in shallow water in the plain, and in P. (Punjab) only.

History of invasion: According to Mirza (1993), it has grown as a common weed of rice in the G. W. and in the S. W. However, its history of invasion is not known. It is found in rice fields in Punjab and Sindh.

Management: Since it is a weed of waterlogged and saline soils, therefore introduction of salt-tolerant crops may reduce the problem. Moreover, flooding of affected lands with water for 2-3 days in hot weather, after cutting the upper portion of the plant and growth of the lower part, which is often cut and so is decomposed through the effect of proso millet, may be effective.

13. *PARTHENIUM HYSTEROPHORUS* L. (Family: Asteraceae) S. A. Fl. 8: 81, 1845; Com. on Det. Rice, Nat. & Dept. Agric. Press, Calcutta 1918.

Distribution and habitat: It is a recent introduction in the subcontinent. It is a common annual weed of rice in the G. W. and in the New. It is found in lowland, sloping, open, grassy, hilly, and in stream banks, ditches, and ponds, and in shallow water in the plain, and in P. (Punjab) only (Clayton et al., 2000). It is a road-side rare weed in the Himalayas and in the *Cambes* series in future. Although present in many parts of rice fields in the NWFP, more of wetter areas, Islamabad and environs, where it is a common weed of lowland, sloping, open, grassy, hilly, and in stream banks, ditches, and ponds, and in shallow water in the plain, and in P. (Punjab) only. It is a common weed of rice in the G. W. and in the New. It is found in lowland, sloping, open, grassy, hilly, and in stream banks, ditches, and ponds, and in shallow water in the plain, and in P. (Punjab) only. It is a common weed of rice in the G. W. and in the New. It is found in lowland, sloping, open, grassy, hilly, and in stream banks, ditches, and ponds, and in shallow water in the plain, and in P. (Punjab) only. It is a common weed of rice in the G. W. and in the New. It is found in lowland, sloping, open, grassy, hilly, and in stream banks, ditches, and ponds, and in shallow water in the plain, and in P. (Punjab) only.

Parthenium weed has allelopathic effect on the stigma of other species, mainly rice and wheat. It is a low growing weed that competes indigenous species. The weed is a prostrate herb that grows up to 1m tall. It has invaded all types of rice fields in the G. W. and in the New. It is a common weed of rice in the G. W. and in the New. It is found in lowland, sloping, open, grassy, hilly, and in stream banks, ditches, and ponds, and in shallow water in the plain, and in P. (Punjab) only. It is a common weed of rice in the G. W. and in the New. It is found in lowland, sloping, open, grassy, hilly, and in stream banks, ditches, and ponds, and in shallow water in the plain, and in P. (Punjab) only.

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History of Invasion: According to Khalid (2000), it has spread over large area along roadside without mentioning its history of invasion.

Management: As it is a recent introduction, therefore, all efforts including mechanical and use of herbicide may be employed to combat this weed. Biological control can also be tried in research trials.

14. *CANNABIS SATIVA* (Family Cannabaceae). Stewart, Ann. Cat. Vas. Fl. Pak. & Kash. 195. 1972. Qaiser in Fl. W. Pak. No 44: 1-5, 1973. Common name: Hemp, Mirijuaana, Bhang.

Distribution and habitat: Distributed in northern Punjab and NWFP. It is not much aggressive with a medium degree of invasiveness. It invades waste areas, fencerows around farm building usually on bottomland soil. A very adaptable herb from plains to 1000 ft. found along the roadside (Qaiser, 1973), in northern Punjab and NWFP.

History of Invasion: Appears to be an ancient introduction. May be it was initially cultivated for fiber use/ ropes and or drug purposes, which later escaped from cultivation and became wild.

Management: All efforts including mechanical and use of herbicide may be employed to combat this weed. Biological control can also be tried in research trials.

15. *GALUM APARINE* L. (Family Rubiaceae) Sp. Pl. 108, 1753. Stewart, Ann. Cat. Vas. Fl. Pak. & Kash. 684. 1972. Common name: Catchweed, bedstraw.

Distribution and habitat: Widely distributed in Pakistan from plains to 12000 feet. It is a troublesome weed in winter crops, mainly wheat. It interferes with harvesting, encourages lodging, and sometimes smothers an entire crop.

History of Invasion: It is a native of Europe. Apparently old introduction probably came with crop seed. The small size of the seeds enhances their mixing with crop seeds; small hooks on the seed coat also provide a special mechanism for attachment to fur, bags and clothing, which help in transportation of the weed seeds from one to other place.

Management: As it is weed of wheat, therefore rotation with other crops combined with broad-leaf herbicides (Table-2) of wheat can reduce the problem.

16. *EMEX SPINOSUS* (Linn.) Campd. (Family Polygonaceae) Monogr. Rumex, 58, 1 (1819); R.A. Graham in Turrill & Milne-Redhead, op.cit.3 (1958); Tutin in Tutin et al., op.cit.1:89 (1964); J.Cullen in Davis, op.cit. 2:293 (1966); Rechinger & Schiman-Czeka in Rechinger, op.cit. 2(1968). (Syn. *Rumex spinosus* L.; *Emex spinosus* L., Sp. Pl. 337 (1753); Bhopal & Chaudhry in Pak. Systematics, 1(2):97-98, 1977. Common name: Prickly dock; Kafir kanda

Distribution and habitat: S. Europe, Mediterranean Coastal countries and SW Asia. Very common weed of wheat in Peshawar valley, Nizampur, Attock and Haripur area.

History of invasion: It has been accidentally introduced recently from Afghanistan & Iran (Bhopal & Chaudhry, 1977), probably through goats and sheep.

Management: It is a very competitive weed of wheat, thus wheat broad-leaf herbicides (Table-2) combined with crop rotation will show promising results.

Table 1. Farmer's response to invasive weeds based on indigenous knowledge

Name of the weed	How became Invasive	Remarks
<i>Xanthium strumarium</i> (15)	Through sheep and Goats/FYM	Came from northern Afghanistan through sheep and Goats
<i>Ipomoea eriocarpa</i> (2)	FYM/Fodder	FYM seem cause of its spread.
<i>Alternanthera pungens</i> (1)	Through seed of vegetables & goats (sticky fruit)	Grazing animals and FYM is the cause of its spread.
<i>Trianthema portulacastrum</i> (10)	Through seed of vegetables	Biggest problem of vegetables problem
<i>Tagetes minuta</i> (2)	Wind/Seed/Farm machinery	Very tall, insect repellent
<i>Imperata cylindrica</i> (2)	Wind	Troublesome weed of perennial orchards & undisturbed soils.
<i>Amaranthus hybridus</i> (10)	Birds, wind, FYM	Very tall, used as pot herb.
<i>Robinia pseudoacacia</i> (7)	Cultivation along Road	It is spreading along road side & replacing local trees
<i>Broussonetia papyrifera</i> (2)	Cultivation/Birds	Found near Haripur only (Personal observation).
<i>Ailanthus altissima</i> (5)	Cultivation	Weedy tree of abandoned fields, graveyards and roadside.
<i>Pistia stratiotes</i> *	Not known	Found near Tarbela (Personal observation)
<i>Phragmites australis</i> *	Not known	Fiber recovery weed
<i>Parthenium hysterophorus</i> *	Not known	Used as repellent
<i>Cannabis sativa</i> (11)	Through FYM and fuel use.	Used in drugs, sedative, has cooling effect
<i>Galium aparine</i> (5)	Through wheat crop seed & sticky nature of plant	Competitive with wheat
<i>Emex spinosus</i> (2)	Through wool of sheep and goats	Competitive with wheat

* Through personal observation in the field.

Note: Figures in parenthesis denote the number of respondents.

Table-2: Major categories of herbicides used in non-crop, Maize, Wheat, Rice and Vegetable

	Group of herbicides	Name of herbicides
I.	Non-Selective Herbicides:	1. Roundup (glyphosate) 2. Paraquat (gramaxone)
II	Herbicides for maize:	1. Primextra (metalochlor+atrazine), 2. Stomp (pendimethalin), 3. Treflan (trifluralin)
III	Herbicides for wheat A. Grass killers:	1. Topik (clodinafop) . 2. Puma supper (fenoxaprop-p-ethyl) 3. Isoproturon
	B. Broadleaf killers:	1. 2,4-D. 2. Buctril-M (bromoxynil · MCPA). 3. Logran (triasulfuron)
IV	Herbicides for rice:	1. Saturn (thiobencarb). 2. Machete (butachlor). 3. Ronstar (oxadiazon)
V.	Herbicides for Vegetables:	1. Stomp (pendimethalin). 2. Tribunil (methabenzthiazuron)

CONCLUSIONS AND RECOMMENDATIONS

1. Legislation is required to discourage introduction of alien species, which can pose a major threat to the environment in the future. For example, the ill planning regarding introduction of *Robinia pseudoacacia*, *Broussonetia papyrifera* and *Ailanthus altissima* has resulted in losses, which can not be repaired in the near future. Before any alien plant is introduced, the weed scientists must be consulted in this process to avoid any future mishap of this kind.
2. Most of the farmers interviewed yielded an important part of information through their years-old experience acquired from their ancestors. Large farmers proved more willing to risk investing in yield-enhancing technologies if they could be assured that it could translate into more revenue. While small farmers had little or no cash to spare and preferred hand hoeing yet they readily accepted the need to replace it with an efficient and less laborious weed control method.
3. With the global shift in information technologies, our local values are rapidly changing. As a result, the younger generation is not equipped with the centuries-old indigenous knowledge regarding plants; therefore, we were constrained to visit aged farmers who could answer the questions. Thus all efforts are needed to conserve this knowledge before it is too late, as there is a generation gap and once the old generation is phased out; there will be no one to seek answers to such issues.
4. Similar diagnostic surveys should be carried out for timely intervention and resolution of issues related to environments.

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