

Review

Indigenous pest and disease management practices in traditional farming systems in North East India: A review

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Traditional farming system is an ecologically based age-old farming system developed by ancient farmers through generations of their interaction with nature and natural resources for food, fodder and fiber. Indigenous knowledge is the knowledge of the indigenous people inhabiting different geographical regions of the world with their own language, culture, tradition, belief, folklore, rites and rituals. This report is an attempt to document some of the indigenous practices followed by traditional farmers for the management of pests of certain common crops grown in traditional farms in general and north east India in particular.

Key words: Agricultural farming, indigenous traditional knowledge, pest and disease management, traditional ecological knowledge.

INTRODUCTION

Traditional farming system is an ecologically based age-old farming system developed by ancient farmers through generations of their interaction with nature and natural resources for food, fodder and fiber. It is an indigenous method of cultivating crops using self reliance locally available resources without external inputs. Indigenous farming system, once prevalent all over the world is now almost vanished from the developed countries and confined to some tribal dominated regions of developing countries occupying more than half of arable land (Thurston, 1992). Wherever they are, the common feature of traditional farming is the presence of spatial and temporal heterogeneity often with complex plant age structure, mixed cropping, multiple, host-pathogen interactions and use of simple tools to plow and harvest the crop. India is rich in traditional farming systems because of diversity in agro-ecological habitats inhabited by diverse ethnic groups who have been practicing age-old farming in location specific situations since generations. It is a community based farming system that brings the local people closer and respects their environment.

Tools and techniques used by them are either unknown or least understood. However, with the advent of modern

agriculture, traditional farming in India is largely confined to hilly regions that too in peripheral states where green revolution could not influence the traditional farmers. Crops and pest scenario of crops in traditional farming system is by and large same as that of the conventional agriculture but degree of severity caused by various pests may differ. Management of crops in general and pest management approaches in particular are different among traditional farmers practicing traditional farming systems in different regions of the country because of difference in indigenous knowledge they accrued over generations of their close contact with the nature for evolving sustainable and locally adapted agriculture system.

Traditional farming system in north east of India is complex and unique of its own as the land use system in these regions is dominated by slash and burn agriculture where management of crops and pests are carried out by integrating indigenous knowledge and traditional ecological knowledge of the communities. This twin knowledge have been recognized by the world scientific communities and scientists are showing keen interest in traditional agriculture because indigenous farmers and their system may be of great help to remedy the deficiencies of pest management in modern agriculture

(Sofia et al. 2006). Attempt is being made here to document some of the indigenous practices followed by tra-

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ditional farmers for the management of pests of certain common crops grown in traditional farms in general and north east India in particular.

About indigenous/traditional knowledge

Indigenous knowledge is the knowledge of the indigenous people inhabiting different geographical regions of the world with their own language, culture, tradition, belief, folklore, rites and rituals. In course of their close interactions with nature and natural resources, they are to make a certain decisions as to the solutions of their problems they encounter in their day to day life while managing the land and environmental resources for survival. Compelling situations motivate them to generate knowledge out of necessities. Therefore, indigenous knowledge so developed is based on necessities, extinct, curiosity and observations of ethnic groups to mitigate the immediate situations. Hence, indigenous knowledge is used in the decision making process as to how, when and where to act depending on the situations.

This knowledge has been tested using the thumb rule of trial and error methods over a period of time through generations and validated to make the established knowledge for the purpose for which it is designed for use of the ethnic group who propounded for the first time. Thus, indigenous knowledge varies from tribe to tribe and usually passes on to the next generations though the words of mouth, actions or even practices, usually by the elders of the family/society. In fact, these ethnic bases cumulative knowledge took generations of time to penetrate into the social fabrics of inter and intra- ethnic groups because of communications gap and orthodox nature of the society. Eventually, this local knowledge in course of time, gets socially accepted and validated which finally inters into the social life and subsequently become the Indigenous traditional knowledge (ITK) of the society as a whole. Thus, socially validated indigenous knowledge which shares common values and gains popularity with human element attached to it particularly the culture of the ethnic groups may be known by the name Indigenous traditional knowledge. However, now days it is known to people synonymously by various modern names such as indigenous technical knowledge, technical know how of indigenous people, peoples knowledge etc. (Singh and Sureja, 2008).

Indigenous traditional knowledge is distinct from international knowledge which is derived through hypothetico-inductive process such as knowledge generated in universities, research organizations, private and public research institutions through research activities. As such, scientists in recent years are keen to learn indigenous knowledge in its various dimensions as to how indigenous people view, perceive and interact with their environment and mobilize their cumulated knowledge for designing appropriate actions. Although many people, so to say self styled modern educationists have discarded this

knowledge branding them as outdated primitive knowledge, yet its importance and hidden principles, particularly in the field of agricultural and environmental issues have been recognized by international bodies such as the united nations conference on environment and development, 1992; international union for conservation of nature and natural resources, 1980 and world convention on environment and development, 1987 (Kanoujia, 2004). As such, scientist in this knowledge base economy who are in research of new ideas and innovations expect that indigenous knowledge may hold significant message which may be of use to remedy the deficiencies in modern agricultural and environment related issues (Berkes et al., 2000).

Despite its potentiality in addressing the environment issues including agriculture, indigenous traditional knowledge could not develop to its fullest extent primarily for fast technological development and secondly due to crude and outdated nature of the knowledge, that too in the process of degeneration with the passing away of elders and finally due to the exposure of the society to their modern innovations. As the elderly persons in any ethnic group hold the key and custodians of the traditional knowledge, they are the masters to make correct decisions to overcome the adverse situations of their immediate environment. Being a local need based knowledge, indigenous traditional knowledge system is based on local resources without any external inputs. Eco-friendly manipulation of their immediate environment, judicious application of plant and animal products either in raw or simple processed forms are important components of indigenous knowledge system. Land being the basis of survival of mankind, indigenous knowledge system of indigenous people revolved mostly about the ecological management of their land and environment in harmony with nature. Here lies the importance and significance of indigenous traditional knowledge and therefore it should be protected, preserved and documented in the interest of future generations before it is lost.

Indigenous disease and pest management practices in traditional farming system

In recent years there is a resurgence of interest in reviving the age old farming system through scientific approach which is known by modern man as organic farming, because of hazardous effect of excessive chemicals in agricultural system, environment and human health. Further, the negative impact of green revolution such as loss of genetic diversity of indigenous crops because most farmers confined production in mono cropping of selected crops (maize, rice, wheat) ignoring indigenous crops, stagnation in crop production even with the increase dose of chemical fertilizers, development of pesticide resistant pests, emergence of new pests which were either non-existent or present as minor pest degradation of arable land to the extent of unfit for cultivation without the appli-

cation of synthetic chemical fertilizer and overall ill effects of chemical based products to human health etc are some of the challenges which invoke to look for alternative farming system that minimizes the use of chemicals (fertilizers or pesticides). Indiscriminate use of pesticides that results killing of natural enemies of pests, beneficial soil micro organisms and its residual effect in food chain necessitates the development of integrated pest management concept to minimize and judicious application of pesticides as last resort if other eco friendly alternative methods fail to contain the harmful agricultural pests. However, the success story of IPM is limited to few crops only and as such, search of viable alternatives for the management of pest is an ongoing process.

India is a large country with diverse agro-climatic habitats, arable land, crops and cropping pattern suitable for growing location specific crops being cultivated by hundreds of ethnic farming communities with their own indigenous technologies. Therefore, crop cultivation practices vary not only from one agro-climatic zone to another but also from one ethnic group to another. These ethnic farming communities are the store house of indigenous knowledge of technical knows how regarding the overall management of indigenous crops. The uniqueness of this knowledge is that it is environmentally benign, ecologically protective, socially acceptable, economically viable and sustainable. In appreciation of technical know how knowledge of ethnic groups, attempt is being made to collect, document and understand the rationale behind the traditional practices in general and pest management in particular which are disappearing at fast rate under the influence of high tech modern agriculture. While doing so, it not only preserves the age old agricultural heritage of the country and identity of Indian farmers but also promotes the scientific development of traditional practices with honour and dignity of indigenous farmers for sustainable agriculture because it holds the potential eco friendly message for pest management.

North eastern region of India bestowed with natural beauties and biodiversity resources is rich in eco friendly indigenous knowledge maintained and nourished by hundreds of ethnic tribes (more than 120 ST) and communities. Despite diversity in ethnicity, they practice a common but unique farming system locally called jhum around which their culture and tradition revolves. In this farming system farmers grow as many as 35 crops (Ramakrishnan, 2004) in mixed, multiple or polyculture form of which rice is the staple food crop that dominates the system in Manipur, Nagaland, Tripura, Arunachal Pradesh but potato in Meghalaya. Whatsoever be the cropping pattern, the cultivation practices are eco friendly and tuned to the need of the people. Irrespective of ethnic groups practicing jhum, interesting features of the system is that it has inbuilt pest and disease management mechanisms as reflected in their cultural practices such as mixed /multiple cropping, zero tillage, clean cultivation, slash and burning, green manuring, sequential cropping and harvesting, fallowing, flooding etc.

Use of plants and animal parts and products are the important components of indigenous knowledge in the management of pest and diseases of crops in jhum system. Indigenous farmers of the region also possessed rich traditional ecological knowledge such as growing location specific nitrogen fixing trees such as *Alnus nepalensis*, *Flemingia vestita* sparsely for enrichment of soil fertility keeping tree boles /trunk and erecting /pegging wooden structures amidst jhum/ terrace fields for facilitating perching of birds which prey on harmful crop pest, recycling of jhum based waste products for the management of crops etc.

Traditional cultivation practices, although it was jhum only in the past but due to population explosion, jhum cycle has been reduced due to population explosion, Jhum cycle has been reduced to 2 - 3 years, some of which have been converted to terrace wet farm while others to sedentary form of agriculture. Thus, jhum system of cultivation have undergone changes to terrace form to settled agriculture forms which one finds in mixed forms at different locations in N.E. Some of the indigenous traditional knowledge (ITK) being used by these traditional farmers in all the 3 system of crop cultivation have been explained with rationale which may be of use for integration in the existing IPM concept.

Traditional belief - a myth or reality

Indigenous people have rich store house of traditional beliefs, folklore, rituals and rites which may not hold any truth and have any practical value but expected to hold some message and therefore need in depth observation in the light of empirical sciences to discover some of these beliefs as sound agricultural practices. These beliefs include that seeds collected and thrashed on new moon day (Amawasia) for sowing in the next season are usually not infested by pest and pathogens, plant diseases are caused by halo around the sun, sowing seeds should be sprinkle first with gold water etc. North eastern region of India being the home of rich culture and nature friendly traditional knowledge, these beliefs have been shaped and nurtured by hundreds of ethnic groups scattered throughout the regions.

Conclusion

Formal pest and disease management knowledge and ecological knowledge derived through hypothetico-deductive method whereas indigenous pest management knowledge and traditional ecological knowledge derived through long experiences and perceptions accumulated by traditional farmers during the course of their interactions with the nature and natural resources need to be effectively integrated and should not be viewed in isolation.

Although indigenous pest and disease management knowledge fitted well in the age-old land use system, yet need thorough validation in view of changing agricultural

scenario from traditional to integrated farming system through inorganic and organic farming methods. Some of this validated Indigenous traditional knowledge (ITK) may be incorporated as an integral component to dovetail neatly into the IPM concept for evolving better pests and disease management strategies in any of these farming systems.

This systematic approach not only protects this fast disappearing ITK under the influence of modern agriculture but also preserve the indigenous pests and disease management identity of farming communities of this country. Therefore, this rich heritage of the county should be harnesses, preserved, documented and developed as modern science such as indigenous integrated pest management before they are lost.

REFERENCES

- Berkes F, Colding J, Folke C (2000). Rediscovery of traditional ecological knowledge as adaptive management. *Ecological Applications* (10 (5): 1251-1262.
- Chhetry, GKN (2008). Personal observations.
- Ramakrishnan PS (2004). Sustainable development of jhum with conservation of biodiversity in North-East India: Where do we stand? *Man and Society* 1(1): 59-85.
- Singh RK, Sureja AK (2008). Indigenous knowledge and sustainable agricultural resources management under rainfed agro-ecosystem. *Ind. J. Trad. Knowledge* 7 (4): 642-654.
- Sofia PK, Prasad R, Vijay VK (2006). Organic farming- Tradition reinvented. *Ind. J. Trad. Knowledge* 5: 139-142.
- Thurston HD (1992). Sustainable practices for plant disease management in traditional farming systems. West views Press, Boulder.

APPENDIX

S/No.	Name of indigenous traditional knowledge (ITK)	Details of ITK and rationale	Reference
1	Management of seed health free from pest and diseases in jhum, terrace, sedentary and home garden traditional farming system.	<p>Good seed health is managed for sowing in the next season through:</p> <ul style="list-style-type: none"> (i) Collection of healthy seeds before general harvest (ii) hanging over fire furnace/ kitchen for constant smoking (iii) mixing with ashes of fire wood (iv) smoking well dried healthy seeds with edible and non- edible oils (v) Mixing with neem seed powder etc and storing the same in a seed bin. (vi) using aromatic plants such as citronella grass, lemon grass, peels of pomelo etc against maize weevil by mixing /placing these plants over maize grains granary. <p>Rationale: Unsuitable environment is created to inhibit the growth and proliferation of pest and other microorganisms. Aromatic plants act as repellent or fumigant e .g; Leguminous seeds ,vegetable seeds, maize etc. (tribals and non-tribals of N.E)</p>	Chhetry, 2008
2	Methods of keeping seeds free from pest and diseases for use in traditional farming system	<p>Seeds of maize and leguminous crops are often kept intact along with their outer husk and hang over the kitchen/ furnace. Here, maize cobs are tied up in bunches of 10 - 12 cobs by folding their next to outermost husk and hang over the wooden beams of kitchen and sometimes roof beam in the periphery of the house.</p> <p>Rationale: Open air mixed with smoke seemed to inhibit the pest and pathogen as well as the entry of this pest take time through hard husk of maize and beans.</p> <p>(Tribal and non- tribal, N.E.)</p>	Chhetry, 2008
3	Storage method of paddy in traditional granary for keeping away pest and pathogens.	<p>Specially prepared bamboo granaries plastered with mixture of fresh cowdung and mustard oil cakes are in use for storing paddy on the top of which branches with leaves of <i>Zanthoxylum acanthopodium</i> are placed to keep away pest mostly white butterflies -a common pest-of the stored paddy grains. Paddy granaries are either placed near the kitchen or vicinity to kitchen in a separate house.</p> <p>Rationale: Well plastering of bamboo crevices inhibits the entry of pest and pathogen .It may also be possible that oil cakes emits unfavourable odour to pest and diseases. Further, <i>Zanthoxylum acanthopodium</i>-a plant of carminative properties emits unpleasant smell that inhibits the white flies.</p>	Chhetry, 2008

4	Foliar application of plant and animal products for the management of pest crops: and diseases.	<p>Following traditional methods are used for the management of pest and diseases of</p> <p>(i) foliar application of wood ashes in the wee hours of the day keeps away aphids pod borers and diseases from plants (mostly vegetables)</p> <p>(ii) Dusting finely ground tobacco leaves keep the aphid pest and diseases away from plants.</p> <p>(iii) Hookah water is very much effective for controlling pest and diseases of major and minor crops such as blast of rice, pod borers, sucking bugs of vegetables etc.</p> <p>(iv) Dusting with saw dust is also sometimes used but their effect is not encouraging.</p> <p>(v) Fish and meat wash water application is also a mild deterrent in keeping away of pest due to unpleasant environment for the proliferation of pest and pathogens.</p>	Chhetry, 2008
<p>Rationale: Thin film of ash coat with dew inhibits the attack of pest and pathogens. Ash also acts as a nutrient when it gets washed due to rain.</p> <p>Tobacco leaves and hookah water which contains nicotine prevents the foliage from pest and pathogens.</p> <p>(Well practiced traditionally in the N.E.)</p>			
5	Management of fungal diseases and insect pest of upland paddy.	<p>Pest and diseases of paddy are controlled/managed using the following traditional methods:</p> <p>(i) By spreading leaves of <i>Artemisia vulgaris</i>, <i>Croton caudatus</i>, <i>Munromia wallichii</i>, <i>Adhatoda vessica_etc.</i></p> <p>(ii) By erecting or pegging branches of <i>Cymbopogon khasianum</i>, <i>Saccharum spontaneum</i> which inhibits stem borer of paddy.</p>	Chhetry, 2008
<p>Rationale: Leaves of these medicinal plants on decomposition release substances /molecules which inhibit the pest and pathogen of paddy in jhum land (Manipur, Meghalaya, Sikkim)</p>			

6	Management of diseases and pest of rice through plant products	<p>Pest and diseases are also managed by</p> <p>(i) Pomace (wine residue) Here, well fermented wine pomace usually made up of millets are placed at the source of irrigation canal of terrace rice fields which slowly spread over the rice field and inhibits the growth of pests such as leaf folder and blast of rice .</p> <p>(ii) Oak tree bark are also grounded and placed over the source of irrigation canal which inhibits the insect pests of rice such as brown plant hoppers.</p> <p>Rationale: Unpleasant odour of pomace may be the reason behind inhibiting the fungal disease and leaf folder in particular.</p>	Chhetry, 2008
7	Management of blast and chara problem in terrace as well as in settled wet land paddy.	<p>Traditional farmers use paddy husk before five months to contain the blast of rice at 0.3 to 0.5 ton/h for effective control of blast disease of rice. Paddy husk also makes clay/ loamy soil porous for better aeration of plants /tillers. Chara, a green alga infested field water is drained off first and paddy husk were applied to get rid of chara problem in the field .This method is also effective for controlling blast of paddy.</p> <p>Rationale: After draining of water, chara get settled on the ground which when paddy husk is applied suppress the chara and get decomposed which becomes nutrients of the plant on irrigation of field again. Chara do not have the chance to come up and suck the nutrient meant for paddy again (Mao, Maram, Ukhrul, Manipur).</p>	Chhetry, 2008
8	Management of thatch grass - a nuisance weed common in jhum rice field.	<p>Thatch grass (<i>Imperita</i> ___ <i>cylindrica</i>) is a common weed in jhum fields often not only inhibits the healthy growth of paddy but also acts as alternate host of diseases and perches of brown plant hopper of paddy .This menace is usually overcome by cultivating cassava (<i>Manihot esculenta</i>), <i>Sesamum indicum</i>, <i>Glycine</i> ___ <i>max</i> and <i>Cajanus</i> ___ <i>cajan</i>_ plants densely. This technique is very effective.</p> <p>Rationale: The ramification of the root system of these plants make the soil loose and it may also possible that root exudates of the plants inhibit the growth of thatch grass.</p> <p>(Manipur, Meghalaya, Arunachal Pradesh and Assam)</p>	Chhetry, 2008

9	Control of nematodes in ginger chillies, tomato and turmeric by intercropping <i>Chrysanthemum coronarium</i> .	Nematodes of turmeric, tomato, chillies and ginger are controlled by either intercropping with <i>Chrysanthemum coronarium</i> , <i>Tagetes erecta</i> , or growing <i>Tagetes erecta</i> as border crops. This is a very effective method and often farmers incorporate leaves of these trap crops into the soil to enhance effectiveness and nutrients enrichment of crops. Rationale: The sharp smell of trap crops may be the reason in the inhibition of nematodes.	Chhetry, 2008
10	Cultural practices in the management of crops on jhum system	<p>Traditional farmers manage the pest and diseases of paddy (major crop)and vegetables through cultural practices as the system has inbuilt mechanisms for the control of pest and diseases that include:</p> <p>(i) Burning of slashed debries which kills the resident pests and pathogens from the system because many plants and grasses serves as the alternate host of crops .This clean cultivation practices enable farmers to harvest crops less infected by pest and pathogen .</p> <p>(ii) Zero tillage practices (often seeds are sown by dibbling methods) enables the natural growth of nodulated frankia found in socially valued alder trees and undisturbed mycorrhizal root of slashed plants that promotes the healthy growth of crop plants.</p> <p>(iii) Mulching through the removal of unwanted weeds soon after the establishment of paddy .The decomposed mulch may inhibit the pathogen propagules and also provide nutrients to crop plants. It also protects the soil from erosion in jhum slopes. Thus, mulching has multipurpose use in jhum system.</p> <p>(iv)Mixed cultivation of rice with sparsely grown maize, legume crops, job's tear (<i>Coix lacryma jobi. L</i>), shorghum and ground vegetables, protects the diseases and pest of rice probably due to the physical barriers of intercrops in the movement of air borne propagules, augmenting microclimate and humidity etc Maize and sorghum not only provide food but also acts as perch for birds to feed on insects and pest of paddy in jhum field. Further, maize plants also serve to locate the burrows of rodents that destroy paddy crops.</p>	Chhetry, 2008

11	Biological management of pest and diseases in jhum cultivated crops	Biological management of pest on jhum cultivated crops include :	Chhetry, 2008
		<p>(i) Keeping tree boles / trunk and partially cut alder trees amidst jhum field which facilitate perching of diverse birds for selective prey of pest such as brown grasshopper of paddy, pod borers of pigeon pea etc.</p> <p>(ii) Growing of intercrops such as maize and sorghum long duration pigeon pea etc. with rice. These crops not only yield food but the main purpose of growing them sparsely in the jhum field is to facilitate perching of birds which pick up diverse pest of rice and other ground vegetable crops.</p> <p>(iii) Growing job's tear which is a medicinal plant that not only serve as alternate food to rodents but the root exudates of this medicinal plant inhibit the root pathogens of the soil. Root exudates of other slashed plants in jhum too probably make significant contribution in the inhibition of root pathogens of jhum crops.</p>	
12	Traditional cultivation for management of pathogen in jhum.	BUN the pest	Chhetry, 2008
		Elaborate preparation of land into ridges for soil conservation and furrows for channeling water which one often finds in high and mid elevation <i>jhum</i> land where fallen <i>pinus</i> needles ,twigs and slashed bushes are burnt by covering with a thin layer of soil drag from furrows . In this technique biological material and soil get burnt slowly by suffocating the whole ridges with smoke. Thus, the whole system becomes sterile making the soil free from soil based pest and pathogen and therefore crops such as potato and ginger raised by employing this technique are often healthy.	
13	Management of diseases and pest of rice in terrace cultivation	<p>Shortening of jhum cycle led to the terracing of land for paddy cultivation. Disease and pest of terrace cultivated paddy is overcome through clean cultivation in the following way:</p> <p>Terraced paddy field bund is well plastered using clay soil of the field to avoid the growth of grass which serves as the alternate host of disease and habitats for number of paddy pest. Sloppy walls of terrace fields too are equally cleaned leaving no room for the growth of grasses. Further, wooden perches are erected for biological management of pest through carnivorous birds.</p> <p>(Mao, Maram, Manipur)</p>	Chhetry, 2008

14	Biological management of pest in sedentary wetland system by establishing perches and conserving sacred grooves	Carnivorous birds such as Egrets and others which prey on leaf folder larvae. Stem borer, grass hoppers etc. of rice in the sedentary wet land rice are facilitated by erecting suitable perches in sufficient numbers. Sacred grooves conserved by community also facilitate perching of birds which effectively manage the unwanted pest from rice field. Further, the excreta of these birds acts as fumigant to the growth of pathogens and hence less pest pathogens are found in wet land rice system wherever there are sufficient number of perches for the birds vis-à-vis excreta.	Chhetry, 2008
15	Cultural practices for insect, pest control in wet valley land paddy and sedentary dry land farming system.	Farmers often plough their field repeatedly soon after harvest for exposing soil inhabiting insect pests, arthropods, nematode etc. to harsh weather and to facilitate natural predators . Insects such as grasshopper, crickets and borers lay their eggs in the upper layer of soil in paddy fields eventually exposed during the course of repeated operation and their eggs either desiccate or preyed by the Egrets and their natural predators. This indigenous repeated ploughing technique for getting rid of soil borne insects which damage paddy crops is very effective in wet land system and dry sedentary farming system. (Manipur)	Chhetry, 2008
16	Control of rodents by smokes through burning of paddy husk and dry chillies.	Rodents cause heavy loss to paddy in jhum fields. To control this menace burrows of rats are stuffed with smoke by burning paddy husk and land race dry chillies variety. Complete control over rodents depends on the number of burrows plugged by smokes Rationale: The suffocating pungent smokes promptly affect the respiration systems of rats and killed. (North East)	Chhetry, 2008
17	Traditional eco-technologies for the management of disease in traditional land use system	Traditional technologies such as bamboo drip method of irrigation of terrace rice which makes rice crops free from contaminated water borne diseases as seen in Arunachal Pradesh, bench terracing in higher elevation for soil conservation vis-à-vis nutrient loss to avoid diseases of crops due to nutrient deficiencies, well adapted techniques of growing potato in the higher elevation compared to paddy at lower elevation to match the soil fertility gradient, emphasis of farmers to grow tuberous crops in shorter jhum cycles as compared to cereals under longer jhum cycles are some of the need based techniques adopted by traditional farmers to avoid nutrient deficiency diseases in crops under traditional land use system in north east.	Chhetry, 2008

18	<p>Traditional knowledge for the management of pest and diseases of crops grown in rotational jhum and sedentary agricultural system.</p>	<p>ecological for the pest and crops grown in jhum and agricultural</p>	<p>In a traditional jhum fallow ecosystem, one often finds socially valued nepalese alder (<i>Alnus nepales</i>) left <i>in situ</i> during slash and burn operation. Sometimes this trees for multipurpose such as:</p> <p>(i) Fixing atmospheric nitrogen because its nodulating roots by frankia -a mycorrhiza which fixes nitrogen efficiently to the tune of 125kg/yr/h (Ramakrishnan, 2004) . As such diseases of jhum fallow crops due to nitrogen deficiencies is either not recorded or not found.</p> <p>(ii) Provide healthy shades to shade loving crops like turmeric, ginger and others. The allelopathic effect of this plant species inhibits growth of pathogens over crops and decomposition of leaves inhibits the soil pathogens.</p> <p>(iii) Ramification of roots enriches the soil through nitrofixation and shoots with profuse branches provide shelter to hundreds of birds which prey on various crop pests and pathogens. Further excreta of these wild birds act as pesticides and fungicides of crops.</p> <p>Similarly, there are other nitrogen fixing legumes such as <i>Flemingia veslita</i>, pigeon pea intercropped with potato and maize are often found in sedentary agriculture system for similar purpose.</p>	<p>Chhetry, 2008</p>
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