

STATUS OF FOREST INVASIVE SPECIES IN MYANMAR

1. Country Background

Geophysically, Myanmar forms a terrestrial corridor between the mainland of continental Asia and the Malay Peninsular. It lies between latitude 10° N to 28° N and longitudes 92° E to 101° E with a land area 67,655,300 hectares (ha). With the snow capped Himalayan mountain range in the north, the deciduous and evergreen forests in valley, hills, and wetlands found along and between three mountain ranges which run from north to south. Most of Myanmar land area is fertile and fed by monsoon rain (Myint Swe, 2004). And Myanmar is home to more than 12000 species of flora (Kress et. al, 2003) and mammal species, 1000 bird species and 300 species of reptiles (Thein Lwin, 1994). Myanmar has diverse types of forest due to varied soil, rainfall and topography. Myanmar has agricultural land with 18 million ha of total arable land and 54 millions of people with 2 percent population growth (MAS, 2002). Forests in Myanmar play an important role in the social-economic sector of the country and also for the environment. Closed forest land area is about 43.3 per cent, degraded forest land area is 7.5 per cent, about 22.8 per cent is shifting cultivation area, and the rest are water bodies and non-forest areas (FD, 2003).

Forest lands belong to the nation and the forest near village tracts are owned by villagers. The forests are classified into reserved and protected public forests. Reserved forests are established and specially managed by the Forest Department. National parks and game sanctuaries come under protected forest areas. Wetland areas which constitute water bodies in Myanmar are protected for migratory birds, fishes, and wildlife. There are lake dwellers who earn their living on produce such as fish products, and vegetables.

Many tourists and natural scientists are attracted to Myanmar for her nature's beauty and traditional customs of the indigenous people. Nature tourism committee was formed on the 12th July, 1996 to support World tourist Development Management Committee of the Government. The objectives of the committee were to boost up the world tourism into Myanmar and to look after the needs and well being during their stay in Myanmar. The renovation and upgrading of (15) stations around Myanmar, to support the nature-based tourism trade was done. The stations can be subdivided according to their nature as follows: There are 7 national parks, 6 game sanctuaries, and 2 camps. These stations provide board and lodging, and access to the surrounding environment (FD, 2003).

2. Forest Invasive Species Background

In the past, researches of forest invasive species was not started in Myanmar locally as well as jointly with any international agency. Therefore, agriculturalists, biologists, foresters and veterinary scientists might not really know how many different alien species there are in Myanmar [Like old saying in Myanmar "to where fresh water and green grass grow, the people will follow (go)]. So also many invasive species will move into new territory. Myanmar with open natural borders and as previously stated, a corridor for the mainland Asia and Malay Peninsular, transborder crossings are not difficult for many alien species. Many are brought in with a friendly gesture thinking they might be beneficial to the country. In old days beans and pigs brought in by some Christian Missionaries for the middle Myanmar.

All the references given in table 2 are obtained from The World Conservation Union (IUCN), The Invasive Species Specialist Group (ISSG), and Food and Agriculture Organization (FAO) databases concerning invasive weed species. To confirm their presence in

Myanmar by checklist of W.J Kress *et.al* (2003) was used. Some trees such as *Prosopis sp.*, *Acacia spp*, *Leucaena leucocephala*, and *Eucalyptus spp.* etc. are brought into Myanmar through seed exchange programs and some are introduced into Myanmar for testing, for greening and for economic purposes. Some species, water hyacinth, water lily, canna, kyetsu-kanakho (*Jatropha sp*), and even some bamboo species, etc can transform into invasive types and became serious threats to the places where they invaded. Many lakes and ponds, natural or man made, put in some water hyacinth or some water lily for aesthetic reason later became clogged with these plants and eventually smaller streams and ponds are dried up. The Invasion or spreading of *Jatropha* species are not very aggressive. They spread in localized manner. Some of bamboo species on the other hand spread very fast in places when people abandoned their taungya and places near where large bamboo breaks are found. Roots penetrate other trees areas and subsequently the trees died down due to competition of the invasive species.

Imperata cylindrica grass: which is also beneficial as well as nuisance to the forest land. They spread when abandoned taungya areas or degraded forest land due to natural or human causes. Burning of forest plantations were due to dried-up imperata grass in summer time. They are useful in that the village people use them as roofing materials (Thatch) for their huts. *Acacia auriliformis*, introduced as trial species for fast growing species and later planted as roadside trees. The flowers from the trees cause irritation to eyes and also cause asthma.

Leucaena leucocephala, (Bawzagaing) introduced to Myanmar around 1978. It was tested for multipurposes and fuel wood. It grows very well and flowers almost 8 months of a year and natural regeneration is very good which makes the plant a nuisance and competition with other plant species very strong (S.M. Wint, 2005)

Ficus spp. is an indigenous/ Indian species which is also invasive species. The birds eat the whole fruit and their droppings including seeds fall on trees and buildings where they germinate and grow which the roots reached the ground and the tree developed, engulfing the host tree (or even buildings and eventually destroyed them. One of the yearly operations by Forest Department is killing the ficus trees which entwined the timber trees in the forest.

Seeds from many acacia species were distributed to Myanmar by Commonwealth Scientific and Industrial Research Organization (CSIRO) for species trial. The following diseases were reported foliar diseases (*Collectotrichum* sp, *Cercospora* sp.), powdery mildew (*Oidium* sp) on *A. auriculiformis*, and leaf spot (*Phaeotrichoconis* sp), black mildew (*Meliola* sp.) on *A. mangium* were found. Canker (*Nectria* sp), heart rot (*Fomes* sp, *Polyporus* sp, *Schizophyllum* sp) and root rot (*Ganoderma* sp.) on *A. auriculiformis* were recorded in plantations of acacia (Wai Wai Than, 2003).

Lantana species were brought into Myanmar by British colonialists before the World War II for esthetic reason. But it happened unfortunately that the species played an alternate host to pests (unknown) which attack the teak trees (U Ohn, 2005).

According to the record of Myanmar Pharmaceutical Industry that the bark of cinchona tree was tested as anti-malaria during at Dawei, Taninthayi division in 1937. It is assumed that was introduced and planted in Myanmar from India possibly by the British government in the prewar days. In 1957, the Forest Department had planted cinchona trees in Thandaunggyi with seeds from unknown source. State scholars of Pharmaceutical Industry brought seeds of cinchona from India and also Pharmaceutical Industry received seeds through UNICEF in 1980. In 2001, *Cinchona ledgeriana* and *c.succirubra* were planted in Thandaunggyi by Myanmar Pharmaceutical Factory (MPF, 1981). The seedlings in the nursery succumbed to the attack by fungi *Fusarium* sp and *Rhizoctonia* sp.

(Wai Wai Than, 2001). The Forest Department of Myanmar has planted 40 ha of cinchona in Bokeyyin township in Taninthayi division this year, 2005. The objective is to supply for quinine production for the MPF (FD, 2005).

Seed of *Abies farbri* Craib was received from China in 2003 and seedlings were started in forest nurseries of hilly region. In 2004, bud blight (*Phytophthora* sp), needle spot (*Alternaria* sp), (*Rhizoctonia* sp), root collar necrosis (*Fusarium* sp) diseases were detected at the seedlings with the threat level of 37.23 % (Wai Wai Than, 2004)

Gmelina arborea seeds were introduced into Myanmar in 1998 through the seed exchange program CAMCORE (N. Carolina State University) although there are native species in Myanmar. The idea might have been to test the exotic provenances were destroyed by insects, *Aloides gmelinae* and *Tingis bessoni* (Hemiptera in Yezin and Moeswe areas in the past (A. Zeya, 1981). It is necessary to see whether the exotic are also susceptible to the insect attack or not.

Eucalyptus are very fast growing exotic species in Myanmar and at one time, many people claimed of being high competitor for water with their neighbouring crops. But it was considered later not a very high threat to the environment. So plantations are still established in Myanmar. From 1997 to 2001, eucalyptus plantations were established in Salu and Thewar forest reserves in Bago Division under the joint project of Nippon Paper Industry (NPI) and Forest Department (FD) for paper pulp. During that time, a hybrid *E.urophylla* was introduced in these plantations and in 1999 a root-rot fungus *Cylindrocarpon* .sp with a threat level of 50% was found in those plantations (Wai Wai Than, Departmental report, 2000). It is assumed that it may be because of introduced hybrid species.

Indigenous species *Pinus khasys* prior to introduction of exotic viz. *P. patula*, *P. caribea*, *P. occerpa*, *P. elliotii* and *P. maximinoides*, no record of shoot borer attack was made in the plantations. But in post-introduction-period of exotics, in the plantation of native species shoot-borer attack appeared. It is assumed that the exotics were the culprits for the attacks (A. Zeya, 1992).

Animals introduced through exchange program into Myanmar are kept in cages and den and therefore is no impact on the environment. The list of the introduced animals are given in table 5.

There are 66 species of migratory birds and 59 species of residential birds in Moyingyi Wetland Sanctuary. Among them three residential birds namely, Indian myna bird (*Acridotheres tristis*), house sparrow (*Passer domesticus*), tree sparrow (*P. montanus*) and red-vented bulbul (*Phycnonotus cafer*) are included in the worst species (ISSG database). But there are not recorded in the list of migratory birds. This is just an example of a region, further investigation in other regions in Myanmar is needed.

Elephant is important for timber logging in Myanmar Timber Enterprise (MTE), Ministry of Forestry. Parasitic diseases related with elephants are described in the table 3.

Bee keeping Department of Myanmar was started to introduce honey bee from Israel in 1979. In 1983, *Apis mellifera ligustica* was imported from USA for honey export. The bees were attacked by parasitic mite *Varroa jacobsoni*. The mites are originated in India in the hollow hived bee (*Apis indica*) and they are now spread all over the world. Before, these mites infected in indigenous species of

bee of Myanmar (giant honey bee, hollow hived honey bee, bush honey bee) no record and no one knows. The bee keepers made them under control by using chemical Mitac. Moth of two different species such as greater wax moth and lesser wax moth infected on bee hives are also found. It cannot be definitely proved that whether these parasites were introduced along with the exotic bees or not (Win Kyi, 2005).

Accordingly to the web site of IUCN there had observed 32 invasive species of insect, aquatic plant, herb, shrub, vine, grass, tree, microorganism, mammal, bird and fish in Myanmar.

3. Management and institutional frame work

Agriculture and Forestry Departments were used to be under one ministry up to 1992. They were separated and reestablished as two different ministries. Myanmar Agriculture Service (MAS) has plant quarantine section which takes control of agricultural crops, plant parts and especially concerning with seeds in import and export matters. Moreover, nationally control of diseases and pests are made. But in the Forest Department no such quarantine department exists. Phytosanitary certificate was issued by the seed section of Forest

Research Institute(FRI) for export and internationally seed exchange program for research purpose only. Diseases and pest control works are being carried out by the forest protection section of the FRI. In Myanmar especially at the Forest Research Institute, lack of trained personnel and inadequate funding make it hard to undertake specific research program. To implement any necessary research program concerning invasive forest species, joint effort of international agencies or institutions or governmental institutions with Myanmar is needed. In Myanmar, taxonomy and anatomy research papers are relatively numerous compared to ecology researches which are rate the department of botany and zoology in the universities.

Notifications Nos.61, 405, 406 and 288 from 1946 to 1947 and, Insects & Pests Act (Amendment) Act, 1944 were legislations to administrative authority by Ministry of Agriculture and Forest (FAO, 1990). Myanmar was a member of the Plant Protection Agreement for the South-East Asia and the Pacific Region in 1959. In 1992, Myanmar was one of the signatories at the Convention on Boiological Diversity at Rio de Janeiro. ASEAN Agreements on the Conservation of Nature and Resources was signed in 1997. Then, Ministry of Agriculture and Irrigation has postulated the Pesticide Law (1990) and Plant Pest Quarantine Law (1993) with the objectives: to prevent quarantine pests from entering into Myanmar by any mean; to suppress efectively the spread of quarantine pests. And also Myanmar became a member of Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITIES, 1997). Forest Department is participating in the Development of National Biosafety Frame Work Project funded by United Nations Environment Programmed (UNEP) in 2003. The government adopted the National Policy on 1994 with the aim to establish sound environment policies in the utilization of natural resources in order to conserve the environment and prevent its degradation.

Ministry of Forestry has promulgated the Forest Law (1992) in which the basic principles encompassed to implement the forest policy and the environmental conservation policy, to prevent the dangers of destruction of forest and diversity. And also has proclaimed the Protection of Wildlife and Protected Areas Law (1994). Myanmar Forest Policy has been formulated in 1995 in a

holistic and balanced manner within the overall context of the environment and sustainable development taking full recognizance of the forestry principles adopted at the United Nations Conference on Environment and Development (UNCED) of 1992.

4. Strategies, mechanisms and measures to control forest invasive species

Assumption can only be made on the number of alien species and their presence in Myanmar. They may come into Myanmar in many ways such as swimming in ballast water of ships, hitchhiking, introduced intentionally for agricultural and forestry purpose. Non native species are transported world wide, both legally and illegally, for agriculture, horticulture, forestry, biological control of insects and weeds, erosion control, the aquarium and pet business, and sport. When these species are released or escaped from captivity or cultivation, some invades became therefore threats and non-beneficial.

Weed control by mechanical, chemical and biological methods were used by MAS. Cost and effectiveness can be measured only regionally and data at national level is not available. However, in forestry sector, mechanical weedings are being carried out during the first to the third years of the plantation establishment. In the forest nurseries, weeding by hand, hoeing and sometimes chemical spraying are practiced.

Administrative System

The Director General of the Forest Department is the management authority with the Director of Nature and Wildlife Conservation Division as the scientific authority for CITIES. There are, at national level, governmental institutions which can be identified as authorities concerning various aspects of invasive species.

1. Ministry of Agriculture and Irrigation (MoAI)
2. Ministry of Forestry (MoF)
3. Ministry of Livestock and Fisheries (MoL&F)
4. Ministry of Science and Technology (MoSc&T)
5. Ministry of Education (MoE)
6. Ministry of Health (MoH)
7. National Commission on Environmental Affairs (NCEA)

5. Facilities and services available for national or regional cooperation

The tools and information are available to share nationally as well as internationally for the forest invasive species. Myanmar has taxonomists for fauna and flora, botanists, remote sensing experts, which all are trained locally and abroad. (Table 1)

Myanmar has, three Ministries, such as Ministry of Agriculture and Irrigation, Ministry of Forestry and Ministry of Livestock and Fishery, under which respective educational institution, the universities and the research institutes exist. All these institutions are capable of undertaking seminar, workshops, data assessment, and control for any invasive species. The above mentioned institutions

have laboratories for pathology and entomology research and at the FRI, there is a herbarium with a collection of more than 22,000 specimens. The laboratories need upgrading and also the scientists and technicians.

Table 1. The following is the list of experts in forestry with their specializations.

Sr no.	Name	Specialization	Department
1. (a)	U Sein Maung Wint	Forestry	FREDA (NGO)
(b)	U Ohn	Forestry	FREDA (NGO)
2.	Dr. Nyan Htun	Genetics & Tree Improvement	UOF& MAAFLFS
3.	U Than Myint	Country Coordinator	WCS
4.	Dr. Myint Oo	Remote Sensing	Planning & Statistics Division, FD
5. (a)	Daw Yin Yin Kyi	Curator of Herbarium	FRI, FD
(b)	Daw Mu Mu Aung	Herbarium	FRI, FD
6.	U Win Myint	Biosafety	FD
7.	Daw Lwin Lwin Thein	Ornithology	NWCD, FD
8.	Daw Thein Kyi	Seeds	FRI, FD
9.	Daw Wai Wai Than	Pathology	FRI, FD

10. (a)	Daw Deliver Htwe	Entomology	FRI, FD
(b)	Daw Khin Mar Myint	Entomology	FRI, FD

References:

- Aung Myint. 1986. Parasitic infection of Burma timber elephants. Timber Cooperation.
- Aung Zeya. 1980. Observation on a root borer of young plantation teak in Prome Forest Division. FRI. Myanmar.
- Aung Zeya. 1981. Two insects doing serious damage to planted Yemanae (*Gmelina arborea*) in Yezin and Moeswe areas. FRI. Myanmar
- Aung Zeya. 1982. Detrimental effects of some insects on germination of teak fruit yield FRI. Myanmar.
- Aung Zeya. 1983. Observations on the effects of some insects on germination of teak seeds. FRI. Myanmar.
- Aung Zeya. 1983. Further Observations on *Tingis beelsoni* (Hemiptera : Tingidae) incident on Yemanae (*Gmelina arborea*). FRI. Myanmar.
- Aung Zeya. 1984. A preliminary report on the mortality of *Pinus khasya* Royle. In Kalaw area. FRI. Myanmar.

- Aung Zeya. 1985 . Further observation on a root borer of young plantation teak in Prome Forest Division with view to its control and prevention in pure teak plantations. FRI. Myanmar.
- Aung Zeya. 1992. Shoot borers of Pinus khasya Royle ex Gord in forest plantations in Myanmar. Part 1. Distribution and Biology. FRI Myanmar.
- MPF.1981. Cinchona plantation report. Pharmaceutical Industry. Myanmar.
- D.F.Waaterhouse.1994. Biological control of Weeds: Southeast Asian Prospects. ACIAR.
- D.F.Waaterhouse.1997. The major invertebrate pests and weeds of agriculture and plantation forestry in Southern and Western Pacific. ACIAR.
- FAO. 1990. Digest of plant quarantine regulation. Rome.
- FAO. 2005. State of the World's Forests.
- FD. 1999. Nippon Paper and Marubeni Trial Afforestation Project Report. Planning and Statistics Division
- FD.2002. Departmental report of establishment of Sithabye plantations. Yangon Division, Bago Division and Ayeyarwaddy Division.
- FD.2003. Forest Department Statistics. Note book.
- FD.2003 Nature tourism of Forest Department. Nature and Wildlife Conservation Division. Myanmar.
- FD. 2005. Establishment of Cinchona plantations report from Taninthayi Division, Forest Department.
- MAS. 2002. Current status and prospects of plant genetic resources conservation and utilization in Myanmar. Workshop on

Conservation and utilization of Plant Genetic Resources (PGR) in Myanmar for Sustainable Agriculture Development and Food Security. Yangon. Myanmar.

Myint Swe. 2004. Application of GIS and Remote Sensing for Conservation and Management of Forests in Myanmar.

Ohn Lwin. 1993. Planting of Eucalypts in Myanmar. Regional Expert Consultation on Eucalyptus. FD, Myanmar.

R.C. Mandal. 2000. Weed, Weedicides and Weed Control-Principle and Practice. Agro bios. India.

Sein Maung Wint. 2005. Personnel Communication. FREDA. Myanmar.

Thein Lwin. 1994. Wildlife Conservation in Myanmar. Myanmar Forestry. A quarterly journal. Vol. 2, No. 1.

UOhn. 2005. Personnel Communication. FREDA. Myanmar.

W. J. Kress, R.A. DeFillips, Ellen Farr, Yin Yin Kyi. 2003. A checklist of the trees, shrubs, herbs, and climbers of Myanmar. US national herbarium volume 45:1-590

Wai Wai Than. 2000. Departmental report of diseases survey on Eucalyptus diseases in Salu Reserved Forest. FRI, Myanmar.

Wai Wai Than. 2001. Departmental report of fungus diseases, *Fusarium sp.* and *Rhizoctonia sp.* incident on seedlings of *Cinchona*. FRI, Myanmar.

Wai Wai Than. 2003. Priliminary investigation of common diseases of *Acacia* species in Myanmar. FRI.

Wai Wai Than. 2004. Departmental report of diseases survey on *Abies* fabric seedlings. FRI, Myanmar.

Websites. 2005. IUCN, ISSG, FAO

Win Kyi. 1985. Termites in Myanmar. M.Sc Assingment. SUNY.

Win Kyi. 2005. Bee Keeper. Personnel Communication.

Win Win Myint. 1997. Preliminary study on the outbreaks of teak defoliator; *Hyblaea puera* in teak plantations. FRI. Myanmar.

Abbreviations

ARDC	Agricultural Research and Development Cooperation
CAMCORE	Central America and Mexico Coniferous Resources Cooperative
CITES	Convention on International Trade in Endangered Species of Wild Fauna and Flora
CSIRO	Commonwealth Scientific and Industrial Research Organization
DFSC	Danida Forest Seed Centre
FAO	Food and Agriculture Organization
FD	Forest Department, MYANMAR
FREDA	Forest Resources and Environmental Development Association
FRI	Forest Research Institute
ISSG	The Invasive Species Specialist Group. NZ
IUCN	The World Conservation Union
MAAFLFS	Myanmar Academy of Agricultural, Forestry, Livestock and Fishery Science
MAS	Myanmar Agriculture Service
MPF	Myanmar Pharmaceutical Factory

NPI	Nippon Paper Industry
NWCD	Nature and Wildlife Conservation Division
UOF	University of Forestry
UNICEF	United Nations Environment Programmed
WCS	Wildlife Conservation Society

Checklist of forest invasive species present in MYANMAR

Table2. WEEDS

S.N	Scientific name	Common name	Origin	Introduction		Likely pathways of spread	Vector	Distribution patterns	Rate of change	Major hosts	Threat level
				Method	Year						
1.	<i>Adenanthera pavonina</i>	Bead tree	India, Malaysia	Ornamental Medicine	n.a	Seeds dispersed by birds	n.a	Natural forest, Coastland, Disturbed areas	High impacts on other plants due to large colonies formation	n.a	R
2.	<i>Ageratum comyzoides</i> L.	Goat weed, Billygoat, Kaduhpo, Khwethaypam	Tropical America	n.a	`	Wind and water	`	Dry land field crops, Plantation crops, Vegetables, Pasture	Vigorous growth, Eye inflammation, Lung problems	`	R
3.	<i>Alternanthera philoxeroides</i> (Mart.) Griseb.	Alligator weed,	South America	`	`	Wind	`	Dry land field crops, Pastures	Spreading vigorously	`	R
4.	<i>Amaranthus spinosus</i> L.	Spiny amaranthus, Hin nu new sue pauk	Tropical America	`	`	Wind and water	`	Cultivated lands, Pastures, Roadsides	Aggressively spread, Livestock poisoning	`	R
5.	<i>Arundo donax</i> L.	Spanish cane, Nana cane, Kyu, Kyuma	India	`	`	Floating vegetables, Landscape, Agriculture, Debris	`	Banks of the river, ponds, streams	Shade out other plants	`	R

6.	<i>Bidens pilosa</i> L	Spanish needle, Black jack, Ta-sae-ut	Tropical America	n.a	n.a	Wind	`	Plantation crops, Up land field crops, Waste places, Garden	Aggressive spread	n.a	R
7.	<i>Caesalpinia decapetala</i> (Roth.)Alston	Mysore thorn, Cat's claw, Suk- yan-bo	Tropical Asia	`	`	`	`	Ranches	Spines caused limited movement of animals and smothering other plants	`	R
8.	<i>Canna indica</i> L.	Canna, Indian short, Queensland arrowroot, Budathrana	India	Ornamental	`	Rhizome	`	Garden, Landscape	Shade out other plant	`	N
9.	<i>Cassia Mimosoides</i> L.	Mezali, Mejari,	Possibly Thai	Roadside tree, Medicinal	`	Seeds	`	Garden, Roadside,	Branchy, Natural regeneration very good	`	R
10.	<i>Caasuarina equisetifolia</i> Forst.	Beefwood, Whistling pine, Casuarina, Pinle- kabwi	Australia	For coastal landscaping, Ornamental	`	Small and winged seeds dispersed by wind and water	`	Garden, Roadside,	Interfered with nesting of turtles and crocodiles	`	R

11.	<i>Chromolaena odorata</i> (L.)R.M.King & HRobinson	Bitter bush, Siamweed, Bizat, Jamani-chon, Zamani-paung,	Central America, South America	n.a	1940	Agriculture, Road vehicles, Seeds stick to boots and animals, Water currents	n.a	Natural forest, Forest plantations, Agricultural land, Fallowed lands, Road-side	Competition and allelopathic on other plants. Bense bush, Skin irritation and Asthma, Toxic to animals	n.a	N
12.	<i>Colubrina asiatica</i> (L.)Brongn.	Asian naked wood, Asian snake wood, Kyway-new	Asia	`	n.a	Seeds dispersed by ocean currents and seed eating birds, Vigorous resprouting	`	Natural forest, Wet land, Coastland	Impact on underline vegetation	`	N
13.	<i>Commelina benghalensis</i> L.	Day flower, Spider wort, Water grass, Hairy wandering jew, Wet-kyut	Old World tropics	`	`	Seeds	`	Upland field crops and waste places, Garden, Roadside	Dense form, Smothering out other low growing plants	`	N
14.	<i>Convolvulus arvensis</i> L.	Bindweed, Deer's foot, Maxipak-paung, Kaukyo-new	Mexico	`	`	Seeds	`	Upland field crops,	Yield reduction	Wheat	N
15.	<i>Cyperus rotundus</i> L.	Nutgrass, Wet-mye-u	India	`	`	Seeds, Rhizome	`	Field crops, Plantations, Vegetables	`	`	R

16.	<i>Digitaria salguinalis</i> L.	Crab grass, Myet-sok, Nwa-chi-myet, Byaing-chi-myet, Myet-naya	Southern Asia	n.a	n.a	n.a	n.a	Up land filed crops, Plantation crops	Yield reduction	n.a	N
17.	<i>Echinochloa crus-galli</i> (L.)P.Beauv.	Barnyard grass, Myet-thi	Old world tropics	`	`	Seeds	`	Low land rice, Wet soil, Agriculture areas,	Yield reduction, Toxic to farm animals	Rice	N
18.	<i>Eichhornia crassipes</i> (Mart.)Solms	Water hyacinth, Water weed, Million dollar weed, Beda-pin	Amazon basin	Ornamental Aesthetic	`	Seeds and stolons are moving in shorelines	Malaria	Canal, River, Ponds, Low land rice	Block water ways, Reduce biological diversity in aquatic ecosystems	n.a	R
19.	<i>Eleusine indica</i> (L.)Gaertn.	Crowsfoot grass, Goose grass, Sin-ngo-myet	Africa, India	n.a	`	Seeds dispersed by grazing animals	n.a	Upland field crops and plantation crops, Marshland, Seashore, Roadside, Waste land	Strong and compete other plants	`	R
20.	<i>Euthorbia Hirta</i> L.	Garden spurge, Asthma plant, Milk weed, Kwe- kyauing min-sae	Tropical America	Medicine	`	Seeds produces abundantly	`	Dry land field crops, Plantation crops, Vegetables, Garden	Rapid growth, Compete other plants, Dense population	`	N

21.	<i>Ficus religiosa</i> L.	Bo tree, Lagat, Pipal, Bawdi-nyaung	India/ Native	Intentionally introduced for religion	n.a	Seed eating birds	n.a	Urban areas, Gardens, Pagoda campus	Engulfing and destroy pagodas, buildings, trees	n.a	N
22.	<i>Fimbristylis miliace</i> (L.)Vahl.	Lesser frimbristylis, grass like fimbristylis, Myet-kunthi-le, Monhnyinmyet	Tropical America	n.a	`	Seeds dispersed by animal	`	Riceland and wet areas	Weed mixed with rice reduced yield	`	N
23.	<i>Hiptage benghalensis</i> (L.) Kurz.	Adimurtte, Benghalealane, Beinnew, Newnathan-gwin	India, Philippines, China, Taiwan	Ornamental	`	Seeds dispersed by animal	`	Dry low land forest	Smotherang native vegetation, Climber choking large trees	`	R
24.	<i>Hypsis suaveolens</i> (L.)Poit.	Bush tea, Wild spikenard, Pin-sein-yaing	Tropical America	n.a	`	Garden waste, Seeds	`	Dry land field crops, Plantation crops, Pastures Road-sides	Cause asthma	`	N
25.	<i>Imperata cylindrical</i> (L.) P.Beauv	Bladygrass, Cogongrass, Thekke	Old world	`	`	Road vehicles, Roofing, Accidental	`	Pastures, Plantation crops, Urban, Wetlands, Natural forest, Coastland	vegetative growth very strong, Invade abandoned forest areas	`	N
26.	<i>Indigophera hirsute</i> L..	Hairy Indigo	Tropical America	`	`	Seeds	`	Field crops, Roadsides, Waste land	Growth vigorously &spread	`	N

27.	<i>Jatropha gossypifolia</i> L.	Kyetsu-kanako, Taw-kanako	India	Medicine	n.a	Seeds	n.a	Pastures, Urban, Semi-desert	Spread and invade new areas	n.a	R
28.	<i>Lantana aculeate</i> L. <i>L. camara</i> L. <i>L. indica</i> Roxb.	Lantana, Sein-na ban, Nadaung-ban	Tropical America, India	Ornamental	`	Garden waste, Nursery trade	`	Grass land, Agriculture areas, natural forest, Planted forests	Poison cattle, Under story competitor in forest	`	N
29.	<i>Lespedeza cuneata</i> G.Don	Chinese bush-clover	China, Australia	Forage, Soil conservation	`	Animals	`	Grass land, Urban Pastures, Roadsides, Drainge areas, Fencerows, Natural forest, Agriculture areas	Spread easily to open areas	`	R
30.	<i>Leucaena leucocephala</i> (Lam.) De Wit.	Leucaena, Lamt oro seeds, Wild tamarind, Bawzagaing, Aweya	Hawaii	Introduced for forage, Nitrogen fixing tree, Wind break, Fuel wood	1978	Animal excretion, Fencing, Seeds germination easily	`	Plantations, Disturbed areas	Form dense, Fast growing, Threatening endemic species, Natural regeneration very strong	`	N
31.	<i>Loranthus scurrula</i> L.	Mistletoe, Kyi-paung	India, Native	n.a	n.a	Birds	`	Natural forest	Parasitic plant on teak causing deformation and dry up gradually	Teak	R
32.	<i>Marsilea minuta</i> L.	Water clover, Clover fern, Ho-na to	Africa or Tropical Asia	`	`	Reestablished itself	`	Wetland, Rice field, Water Ways	Competes strongly with neighboring plants	n.a	R

33.	<i>Melastoma malbathracum</i> L.	Shame, Lintapapyin, Nyaung-ye-o-pan, Kyet-kale	Asia, Papua New Guinea, Australia	n.a	n.a	n.a	n.a	Waste ground and cultivated lands	Spreading vigorously	n.a	R
34.	<i>Melocanna banbusoides</i> Trin	Bamboo. Kayin wa, Tabin-daing wa, Kayaung-wa	Bangladesh	`	`	Seed dispersed by wind, water and animal	`	Forest land	Spreading by root to the surrounding areas, Aggressive	`	N
35.	<i>Mikania micrantha</i> H.B.K.	American rope, Mile-a-minute	Central and South America	`	`	Seed dispersed by wind, animal	`	Damp or swampy places, Natural forest, Planted forest, Urban, Agricultural areas	Heavy shade, Smothering other plants, Compete for water and nutrients	`	R
36.	<i>Mimosa invisa</i> Martius ex Colla <i>M.pigra</i> <i>M.pudica</i> L.	Sensitive plant, Tigayon	South America. Mexico, Amazon. Tropical America	`	`	Seeds, Difficult to harvest	`	Dry land field crops, Roadside, Pastures. Rained wet land rice, Roadside, Field crops	Spreading rapidly through seeds & vegetatively, Thorny, Smothering	`	N
37.	<i>Monochoria vaginalis</i> (Presl.)	Beda, Kadauk-sat	Tropical Asia, Africa	Medicine	`	Small seeds, Large clumps	`	Rice land, Fresh water pool, Canal, Marshy places	Spread rapidly filling up pool, canal and marshy places	`	R

38.	<i>Neyraudia reynaudiana</i> (kunth) Keng ex Hitchc	Burma reed, Cane grass, silk reed, Kyu,Kyu-nabin-kaing	Native	n.a	n.a	Rhizome, seeds dispersed by wind	n.a	Dry pinelands, Marshy areas, Brackish water	To promote frequent fires and out compete native vegetation	n.a	N
39.	<i>Nymphaea alba</i> L <i>N.nouchali</i> <i>Burm.f.</i>	European white water lily, Kyaphu Indian blue water lily, Kya pya	India	Ornamental, Aesthetic	`	Water ways	`	Ponds, Lake	Compete aquatic species and filled up small water bodies	`	N
40.	<i>Oroxylum indicum</i>	Cat's tongue, kyaungsha	India	As vegetable	`	Seeds dispersed by wind	`	Urban-suburban areas, Pasture	Fast growing spread naturally winged seeds	`	R
41.	<i>Paederia foetida</i> L.	Chinese fever vine, Stink vine, Stinky opal berry, Pe-bok-new	Asia	Cultivated as an ornamental	`	Birds, Transport	`	Pasture, Power lines, Natural forest, Disturbed areas	Climb on trees, power lines. Aggressive	`	R
42.	<i>Panicum repens</i> L.	Torpedo grass,	Africa, Mediterranean	n.a	`	Hardiness & enlarged rhizomes	`	Water logged areas	Suppress other plants	`	R
43.	<i>Paspalum conjugatum</i> Bergius	Buffalo grass, Sour grass, Pyaung sa	Topical America	`	`	Spread by stolon	`	Cultivated field, plantation crops, Pastures	Suppress or eliminate other small trees	`	R

44.	<i>Passiflora foetida</i> L.	Stinking passion flower, Sukhagale, Tawsukha	South America, tropical America	n.a	n.a	n.a	n.a	Upland field crops, plantation crops, Pastures	Spread easily	n.a	N
45.	<i>Pennisetum polystachion</i> (L.) Schultes	Mission grass	Tropical Africa	`	`	Seeds and buds propagation	`	Plantation crops, Upland crops, Hillsides	Aggressive & highly competitive growth	`	R
46.	<i>Pistia stratiotes</i> L.	Water lettuce, Ye-salat, Hmaw	South America	Medicine	`	Free floating vegetation	`	Reservoirs, Lowland rice fields, Slowly flowering stems, Marsh land	Multiply rapidly, Block streams	`	R
47.	<i>Polygonum perfoliatum</i>	Minute weed, Tearthumb	Asia	n.a	`	Birds, Water, Transported in nursery stocks	`	Arable lands, Forest edges, Stream banks, Roadsides	Training vine of the buckwheat	`	R
48.	<i>Portulaca oleracea</i> L.	Purslane, Mya-byit, Myet-htauk	Possibly Central America	`	`	n.a	`	Dry land field crops, Plantations, Perennial crops	Spread easily	`	R
49.	<i>Prosopis juliflora</i> DC.	Honey locust, Mesquite, Gandasein	South America, Israel	For dry zone greening	1930 a 1950 a	Resprouting from vigorous root, Seeds	BOC ARDC	Dry land, Shrub land	Aggressive, Poisonous thorn	`	N
50.	<i>Ricinus communis</i> L.	Castor oil plant, Kyetsu, Toon	India	Medicine, Trade	n.a.	Seeds	n.a.	Dry land, Hillsides	Hairs and spines threat others	`	R

51.	<i>Rottboellia cochinchinensis</i> (Lour.) W.D.Clayton	Itch grass, Myet-ya	India	n.a.	n.a.	Seeds abundantly and germinate immediately	n.a.	Dry land field crops, Plantation crops, Vegetables	Dense cover other species, Aggressive weed	Cotton, Maize fields	R
52.	<i>Rudus ellipticus</i> Sm.	Yellow Himalayan raspberry , Chyaga, Lingsan, Shaga, Subwe, Sumwe	Possibly China	Food	`	Fruit eating birds and Mammals	`	Natural forest, Agricultural areas, Grassland, Disturbed areas	Spread easily	n.a.	R
53.	<i>Sida capinofolia</i> L.	Jivika, Katsine, Ta-myet-si-pin	Possibly Central America, Tropical America	n.a.	`	Tough root and seeds	`	Plantation crops, Upland field crops, Roadside	Broom like branch and spines, Spread easily	`	R
54.	<i>Sorghum helepense</i> (L.) Pers	Cuba grass, Johnson grass, Paung-myet-pyu	Southern Europe, North Africa	`	`	Tough root and seeds	`	Plantation crops	Dense cover, Spreading to open areas	`	R
55.	<i>Spathodea campanulata</i> P.Beauv.	African tulip tree	West Africa	Ornamental	`	n.a.	`	Agricultural areas, Natural forests, Disturbed areas	Spread easily to forest and urban areas	`	R
56.	<i>Sphenoclea zeylanica</i> Gaertn	Goose weed, Le-pa-du	Tropical Africa	n.a.	`	`	`	Rice land	Disturbed rice fields	`	R

57.	<i>Syzygiumcumini</i> (L.) Skeels	Java plum, Black plum, Damson plum, Tame, Thabye-phyu, Thabye-kyetchi	Indo-Malaysia	Ornamental, Garden	n.a.	Fruit producer, Birds	n.a.	Natural forest	Spread and regenerate naturally	n.a.	R
58.	<i>Tribulus terrestris</i> L.	Small caltrops, Puncture vine, Tsule	Southern Europe, Africa, Mediterranean	n.a.	`	n.a.	`	Upland field crops, Pastures, Waste places, Roadsides	Easily Spread in open areas	`	R
59.	<i>Tridax procumbens</i> L.	Coat button, ta-bin-shwe-htee, Hmwe zok-negya		`	`	`	`	Pastures, Upland crops, Roadsides	Easily spreading open areas	`	R
60.	<i>Ziziphus jujube</i> L.	Jujube, Chinese date, Zi	China, Native	Medicine, Food, Fire wood, Fencing	`	Seeds, Fruit trade	`	Dry land field crops, Natural forest	Environmental impacts in wood land, Hardy plant spread in dry zones	`	N

R= Regional

N= National

Table 3. INSECTS & PESTS

No.	Scientific name	Common name	Origin	Introduction		Likely pathways of spread	Vector	Distribution Patterns	Rate of change	Major host	Threat level
				Method	Year						
1.	<i>Achatina fulica</i>	Giant African Snail	Nigeria	Accidental	1970	Trade, Water, Ship, Road vehicles	Human pathogens & parasites	Garden, Nursery, Crop lands, Wall of buildings	Feeding on crops, Nuisance, Reproduce in large number	-	N
2.	<i>Dengue haemorrhagic</i> (DHF) virus	-	-	-	-	Through blood sucking mosquito	<i>Aedes albopictus</i> <i>A.aegypti</i>	Forest, marsh land, Buildings, Urban	Dengue	Human	Wide
3.	<i>Japanese encephalitic</i>	-	-	-	-	Through blood sucking mosquito	<i>Culex tritaeniorhynchus</i>	Urban, Ruler	Encephalitic	Human	Wide
4.	<i>Plasmodium fasciprun</i> <i>P.malaria</i> <i>P.oval</i> <i>P.vivax</i> (parasites)	-	-	-	-	Carrying blood from infected persons by mosquito	<i>Anopheles minimus</i> <i>A. dirus</i>	Urban, Ruler	Malaria	Human	Wide
5.	<i>Wunchuria bancrofti</i> (worm)	Filaria	-	-	-	Carrying blood from infected persons by mosquito	<i>Culex quinquefasciatus</i>	Urban, Ruler	Elephaniasis	Human	Wide
6.	<i>Anoplolleps gracilipes</i>	Yellow crazy ant	n.a	n.a	n.a	Trade, Transport	n.a	Agricultural areas, Urban zones	Devastating native fauna & flora	n.a	n.a
7.	<i>Aloides gmelinae</i> <i>Tringis beesoni</i>	-	n.a	1981	-	Transport	n.a	Yemanae plantation	Shoot, Succulent parts, Soft stem	Yemanae	100%

8.	<i>Dioryctria sylvestrella</i> <i>Petrova salweenensis</i> <i>Ryacionia cristata</i>	Shoot borer “ “	n.a	1986 1989	Wound	n.a	Pine plantation	Early defoliation, Growth reduction	<i>Pinus khasys</i>	R
9.	<i>Dichochrosus punctiferalis</i> <i>Pagyda salvalis</i>	Fruti borer	“	1982	Transport	“	Teak plantation	Yield reduction	Stored fruits	57%
10.	<i>Hyblaea puera</i>	Leaf defoliator	“	1997	“	“	Teak plantation	Early defoliation	Teak	36%
11.	Hymenopterous insect	Seed borer	“	1983	“	“	Teak plantation	Poor germination, Yield reduction	Teak	10-30%
12.	<i>Phassus sp</i>	Root borer	“	1980	Wound, Soil pests	“	Young teak plantations	Root injury	Teak	-
13.	<i>Coptotermes gestroi</i> <i>C.travians</i>	Termites	Asia	n.a	“	“	Tropical woods	Decay	n.a	N
14.	<i>Neotermes dalbergiae</i>	Termites	Asia	“	Trade, Transport	n.a	n.a	Wood decay	Dalbergia group. Dahat	N
15.	Teredo	Ship worm	Asia	“	Trade, Transport, Water, ship	“	Salinity marshland, Seaward,	Wood decay	Ship Canoe, Bridge, Wharves	N
16.	<i>Solenopsis germinate</i>	Fire ant	n.a	“	Trade, Transport	“	Crop lands, Barren areas, Grassland, Nesting in the soil	Affect on fauna & flora	Citrus, Sugar cane, Avocado	R
17.	<i>Trogoderma granarium</i>	Khapra beetle	India	“	“	“	Store	Stored products	-	N

18.	<i>Oryctes rhinoceros</i>	Coconut beetle	Malaysia	n.a	Trades & Transport	n.a	Coconut plantation	Yield reduction	Coconut palm	R
19.	<i>Pempheris affinis</i>	-	India, Cambodia	1939	“	“	Cotton field	“	Cotton	N
20.	<i>Orthezia insignis</i>	-	South America	n.a	“	“	Plantation	“	Coffee, Citrus	R
21.	<i>Xylosandrus compactus</i>	Beetle	Asia	“	“	“	“	“	Leucaena. Orchid, Coffee	R
22.	<i>Cobboldia elephantis</i>	Gad fly, Bots	Asia	”	Elephant dung	”	Forest, Marshland, Kaing grassland, Pastures, Elephant camp, Elephant dung	Enteritis	Elephant	N
23.	Warbles	Warble fly	”	”	”	”	”	Warbles	“	N
24.	<i>Fasciola jacksoni</i>	Liver fluke	”	”	”	Snail	”	Fascioliasis	“	N
25.	<i>Dipetalonema sp</i>	Round worm	”	”	”	Mosquito	”	Filariasis	“	N
26.	<i>Paramphistome fluke</i>	Stomach fluke	”	”	”	Snail	”	Paramphistomiasis	“	N
27.		Strongyloid (Nematode)	”	”	”	-	”	Anaemia, Strongylosis	“	N
28.	<i>Trypanosoma evansi</i>	-	”	”	”	Horse fly, Stable fly, Mosquito	”	Surra	“	N

