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Evaluation on Invasive Species Characteristics and Visions of Rural People
to Introduced Species *Prosopis juliflora* (SW.) DC.
in Dry Zone of Myanmar



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**မြန်မာနိုင်ငံအပူပိုင်းဒေသတွင် လွမ်းမိုးနေသောကန္တာစိမ်းပင်
(*Prosopisjuliflora* (SW.) DC. ၏ ထူးခြားသောလက္ခဏာနှင့် ဒေသခံတို့၏
သဘောထားများကိုလေ့လာအကဲဖြတ်ခြင်း**

ဝေဝေသန်း၊ ဒုတိယညွှန်ကြားရေးမှူး
ထွန်းထွန်းဝင်း၊ တောအုပ်ကြီး
သစ်တောသုတေသနဌာန

စာတမ်းအကျဉ်း

ကန္တာစိမ်းမျိုးစေ့များကို ၁၉၅၀ ခုနှစ်ဝန်းကျင်ကအပူပိုင်းဒေသစိမ်းလန်းစိုပြည်ရေးအတွက် ရည်ရွယ်သွင်းယူခဲ့ပါသည်။ ကန္တာစိမ်းပင်ကိုFAO, IUCN အဖွဲ့အစည်းများကinvasive species အဖြစ် သတ်မှတ်ထားရာမြန်မာနိုင်ငံအပူပိုင်းဒေသတွင် မည်မျှလွမ်းမိုး၍ ဒေသခံတို့၏သဘောထား မည်သို့ရှိသည်ကိုလေ့လာထားပါသည်။ စစ်ကိုင်းတိုင်း၊ မန္တလေးတိုင်းနှင့် မကွေးတိုင်းရှိစုစုပေါင်းရွာ (၉) ရွာတွင် GISဖြင့် ပျံ့နှံ့မှုတိုင်းတာမြေပုံထုတ်ခြင်း၊ ကိုင်းတက်၊ မြေအမျိုးအစား၊ မိုးရေချိန်၊ အပူချိန်၊ အစေ့ပေါက်နှုန်း၊ အသီးတောင့်နှင့် ဆူးရှိခါတုပစ္စည်းပါဝင်မှုကိုစမ်းသပ်ခြင်း၊ ဒေသခံတို့၏ ကန္တာစိမ်း အပင်ပေါ်သဘောထားများအား စစ်တမ်းကောက်ခြင်းများကို ၂၀၁၂ ခုနှစ်တွင် ဆောင်ရွက်ခဲ့ပါသည်။ ရွာတစ်ရွာတွင်၂၀ မီတာပတ်လည် အရှေ့၊ အနောက်၊ တောင်၊ မြောက်၊ အကွက် (၄) ကွက်ယူ၍ တစ်ကွက်ချင်းအပင်အရေအတွက်၊ တစ်ကွက်လျှင် (၁၀)ပင်စီကျဘန်းရွေး၍ အမြင့်၊ ကိုင်းဖြာမှုများ တိုင်းတာပါသည်။ အပူပိုင်းသစ်တော ၉.၈%အနက် ကန္တာစိမ်းပင်ပေါက်ရောက်မှု ၀.၂ % ရှိပြီး အစေ့ပေါက်နှုန်း ၅၈.၂ မှ ၇၃ % တွေ့ရ၍ အသီးတောင့်တွင်ပါဝင်သောအဟာရဓါတ်သည် သိုးနှင့် ဆိတ်တို့အတွက် သင့်တော်ပါသည်။ ဆူးတွင်ပါဝင်သောTerpenoidနှင့် Saponinကြောင့် ဆူးစူးလျှင် နာကျင်ကြောင်း၊ မြေအနေဖြင့် အငန်ဓါတ်များပြီး၊အချို့ အချဉ်ဓါတ်များသော သဲဆန်သောနုံးမြေတွင် အများဆုံးပေါက်ရောက်သည်။ မိုးရေချိန် ၁၈-၃၆.၅၉ လက်မနှင့် အပူချိန် ၁၅.၉ - ၄၃ ဒီဂရီ စင်တီဂရိတ် အတွင်းပေါက်ရောက်သည်။ ဒေသခံတို့၏သဘောထားတွင် အိမ်ရှင်မများက ထင်းသုံးရသဖြင့် ထူးခြားစွာနှစ်သက်၍ စိုက်ပျိုးရေး၊ မွေးမြူရေးနှင့် သစ်တောသမားများတွင် ကွာခြားမှု၊ ထူးခြားမှု မရှိပေ။ ကန္တာစိမ်းပင်ကိုထင်းခုတ်ရောင်းသူ၊ မီးသွေးဖုတ်ရောင်းသူ၊ အိုး၊ မီးဖို၊ အုတ်ဖုတ်ရာတွင် ထင်းအဖြစ်သုံးသူ၊ ထန်းလျက်ချက်သူများကိုတွေ့ဆုံမေးမြန်းစာရင်းကောက်ရာ၌ ဒေသခံတို့အတွက် အထိုက်အလျောက်ဝင်ငွေရရှိစေသောမျိုးစိတ်ဖြစ်ပါသည်။ သို့သော် ပွားများလွယ်ခြင်း၊ အစေ့ ပေါက်နှုန်း များခြင်း၊ ဆူးနှင့် မြေအမျိုးအစားမရွေးပေါက်နိုင်ခြင်းစသောကျူးကျော်မျိုးစိတ်များ၏ သွင်ပြင်လက္ခဏာများကြောင့် invasive speciesအဖြစ် သတ်မှတ်ရမည် ဖြစ်ပါသည်။

Evaluation on Invasive Species Characteristics and Visions of Rural People to Introduced Species *Prosopis juliflora* (SW.) DC. in Dry Zone of Myanmar

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Abstract

Prosopis juliflora (Mesquite) was introduced into Myanmar about 1950s for dry zone greening. Evaluation targeted GIS distribution, branching, soil & climate conditions, seed germination, chemical composition of thorn and pod, questionnaire survey of usage and visions in different societies. Four blocks (East, West, South, North) were layout in each village, total nine villages were investigated in 2012. Population and; randomly ten trees of height & coppicing were recorded in each block. Mesquite composition was 0.2% in dry forest cover 9.8%. Height -branching- population were not correlation and not significant among the regions. Seed germination was 58.2 % - 73%. Minerals and feed stuffs of dry pod had suitable composition for cattle except some more or less than other pasture vegetative. Terpenoid and Saponin of thorn may be toxic and pain. Soil sandy loam was dominant with most alkalinity and some acidity. Rainfall 18 - 36.59" and temperature 15.9 °C - 43 °C were observed. Likeness in farmer, husbandry and forester were not significant except housewife. Expenditure and income from woodcutters, charcoal, toddy candy, pot, kitchen stove, and brick baking were estimated, the earnings usage mesquite firewood assumed supporting rural people. *Prosopis* can be stated as an invasive species in Myanmar for its invasive characteristics such as thrive at all from faraway of dry zone; branching; population; tolerance seed germination; outstanding any soil favorable for growing; and all people highlighted the sharp & poisonous thorn. Their attitude "like it for no choice" is absolute proper answer for dry zone people.

Key Words: Invasive; *Prosopis juliflora*; Dry Zone; Evaluation; Rural People; Questionnaire Survey

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1. Introduction

Prosopis juliflora (Mesquite) is a perennial thorny shrub or tree and belongs to Family: Mimosaceae (W.J. Kress *et.al.* 2003). Mesquite was distributed around the world over the last 200 years (Kathirvel&Kumudha 2011). It was native of North, South, and Central America and widespread in most tropical countries especially in the South and South East Asia and Africa growing in 52 countries (APFISN, 2007).

It was consisted in the IUCN new list of 100, and woody invasive species list of Forestry Resource Assessment, 2010 (FAO, 2010). In 2004, it was rated one of the world's top species (Invasive Species Specialist Group of the IUCN, 2004) and three top priority invasive species in Ethiopia and has been declared a noxious weed (Mwangi&Swallow. 2005).

In the United States, it is well known as Mesquite, Myanmar name is Gandarseinn or Gandarya. It was introduced from Israel to Myanmar about 1950s by ARDC - Agriculture and Rural Development Corporation for Dry zone greening program (FREDA, 2005). Only one species of prosopis, *P.juliflorais* distributed in dry zones of Mandalay, Magway and Sagaing Regions, where have well survival although other tree species are slowly growth.

Mesquite was noticed as invasive species its extensive dispersal capabilities, impenetrable thickets, rapid reproduction, thorn threatening, and outstanding viability under extreme conditions. However, it has some advantages such as fast-growing, drought- and salt-tolerant, and with remarkable coppicing power, and fuelwood that can meet the energy requirements of the arid and semi-arid lands (World Agroforestry Center, 2004).) Therefore, the study focus on to determine it is invasive alien species or favorable species in Myanmar.

2. Literature Reviews

2.1. Invasion

Invasions into riversides and degraded rangelands of Africa, Asia and Australia have resulted in high-density populations. The aggressive invasion is displacing native trees, forming impenetrable thickets and reducing grazing potential, agricultural lands and protected areas (World Agroforestry Center, 2004). T. M. Abedino *et.al.* (2009) expressed the invasiveness of *Prosopis* has however become a problem in many parts of the world it has been introduced. Globally, mesquite is reported to "aggressively" invade all sorts of land areas. Indigenous plant and grass species have disappeared and local communities of those semi-arid dry lands although they widely use *prosopis* as a source for fuel or fodder.

From Landsat satellite images dated 1972, 1987, 2000 and 2004 it appears that not much native woody vegetation had existed in the Gandato research area since the early 1970s (Jörn Laxén, 2007). In the Sudan, invading mesquite was reported depress the growth and survival of indigenous vegetation around it (Mwangi&Swallow, 2005).

2.2. Weed

Pjuliflorais classified as a principal weed in Mexico, a common weed in the US and a weed in Australia, Dominican Republic, India, Iraq, and Venezuela. Thickets of the species have become in grazing lands, croplands and along river courses. There is concern on the impacts of native plants suppressing the germination and growth of crops, weeds and other trees. It has been declared noxious weeds in many countries, including Argentina, Australia, South Africa, Pakistan and Sudan (World Agroforestry Center, 2004).

2.3. Climatic Conditions

Mesquite can grow in areas receiving as little as 50 mm (1.97 inches) of rainfall per year. It grows well in high rainfall zones but also grow in areas receiving < 250 mm (9.84 in) thus do not depend entirely on rainfall (D. Geesing & et al. 2004). The tree can grow at 14-34 C with annual rainfall 50- 1200 mm (1.97-47.2 in) (APFISN, 2007).

Shendi (Sudan) had temperature range between 10 - 42 C and rainfall was normally 100 mm (3.94 in) per year. (Jörn Laxén, 2007). It is salt-draught-tolerant, that can grow in areas receiving 50 mm of rainfall per year (World Agroforestry Center (2004).

Mesquite establish itself in a wide range of annual rainfall zones ranging from less than 100 mm in dry coastal zones to more than 1000 mm. and found in areas with up to 1500mm of rainfall (T. M. Abedelnooret.al. 2009).

2.4. Soil

The tree can regenerate from a piece of [root](#) left in the [soil](#), short-term re-growth, remarkable coppicing power. It can thrive on nutrient poor soil and many species are tolerant of salinity and alkaline soil. The tree can switch easily and rapidly from utilizing water source to the other. It is capable growing on sandy, rocky, saline, acid to alkaline, fine texture soil, and seasonally water logged areas (APFISN, 2007). Soil type: Red brown Savanna, Cinnamon, Dark Compact were found; soil P^H 7-8.5 consisted 60%, <P^H 8.5 was 30% and >P^H 6 was 10 % (DZGD, 2009). Anderson, 2005 found that contain high levels of P, K, Ca and Mg and low levels of N and C. They range from acidic to slightly alkaline (Mwangi & Swallow. 2005).

2.5. Seed and Germination

Pod is 10-25 cm long, has several segments, and contains 10-30 seeds. The seed had high germination at 20-40 C (APFISN. 2007). Alliet.al 1988 observed number of seed per pod was average 23.5. Seeds were mostly like to germinate the animals' digestive and the seeds dropped into moist feces by domestic livestock (World Agroforestry Center, 2004).

2.6. Leaves and Pod

Leaves and pod of mesquite supply feed and forage for grazing animals. Felker 1979 described that in Peru, the long sweet pod have been used for human foodstuffs for centuries. Pods have been an essential food source for indigenous peoples throughout the Americas (Pasicznik et.al, 2001).

Pods are valuable fodder in the semi-arid of northeastern Brazil, where fodder scarcity during the dry season. Feeding trials indicated that rations for goats, sheep, cattle and dairy cattle can weight gains and/or milk production when about 60% of the diet consists of ground mesquite pods (World Agroforestry Center, 2004). Sheep fed with 100% or 85% of pods in the

fodder had lost weight, while animals fed with 70% or 55% had gained weight (JörnLaxén,2007).

If mesquitepods are the sole food source for cattle, Ca 1% became sick, and some die with a compacted pod ball in the rumen. Death attributed to high sugar content repressing the rumen-bacterial cellulose activity. (James A. Duke. 1983).

2.7. Minerals and Feedstuffs

Sixteen macro-minerals have been classified as nutritionally essential in sheep diets. They include sodium (Na), chloride (Cl), calcium (Ca), phosphorus (P), magnesium (Mg), Potassium (K), and Sulfur (S). Micro-minerals: iodine (I), copper (Cu), iron (Fe), manganese (Mn), zinc (Zn), molybdenum (Mo), cobalt (Co), selenium (Se), and fluoride (Fl)are required in small amounts(www.SHEEP 201. Info/201/nutrition.html.)

The seven macro-minerals essential to animals are:Ca, P, Na, Mg, K, S, Cl and micro-minerals Fe, Mn, Cu, Zn, Se, Co, I, Cr, Mo and nickel (Ni). However, copper is particularly toxic and Selenium also a toxicin sheep (U.K.Saha and *et.al.* 2013).Consumption of green immature pods reduced appetite and caused weight loss, weakness, alopecia, nervous symptom, diarrhea, fever, dehydration and death of cattle (Gabar, 1986).

Rao and Reddy (1983) reported that nutritive values of pod 16.5% in CP, and 4.2 % in EE. Talpada et al (2002) indicated that contain 13.5% in CP, 4% in EE, Barbosa (1977) showed that pod has 71% in DM and 66.8% in CP digestibility. Barrows and Filho (1986) also expressed mesquite pod had 82.56% in DM and 80.13% in CP. Kathirvel and Kumudha (2011) observed crude protein range from 26.69-29.84 %, seed were rich in minerals such as K, Ca, Mg and P. Alejandro and Alli (1988) found that crude protein constituted 35 % and 10% of the seed and whole pods respectivel.Levels of the macronutrients Ca, Mg, K and P were relatively low in comparison with cultivated legumes.Animal Nutrition Handbook (Chiba, 2009) mentioned that CP 13 %, (26.69 - 29.84%,FAO/WHO,1991); N 2.1% , S 0.21 % were important and Ca:P ratios should be at least 2:1 for sheep nutrition. K 2.99 to 4.35 % was high risk to animal health.

2.8. Thorn

New growth of mesquite has needle-sharp [thorns](#). The spines are tough enough to penetrate the footwear, and can easily puncture [tires](#). The poisonous thorns have been accused harming both people and livestock.Thorn injuries were aware of 21 cases had medical assistance, and four cases of leg amputations in the previous year. New Halfa hospital communicated that thorn injury becomes serious poor hygiene conditions causes of infection(JörnLaxén, 2007). A woman lost her eye following mesquitehorns pricking her eye in Chemonke Village, Kenya (Mwangi&Swallow. 2005).

2.9 .Wood/Charcoal

Mesquiteas much as 75% of the fuelwood needs for rural people in arid and semi-arid India. The Indian Forestry Department produces and markets charcoal through special development corporations (World Agroforestry Center, 2004). It branches are widely used as fencing post,the Gujarat Agricultural University manufacturedabout 300,000 bags of charcoal between1990-1995 for the government of Gujarat (Mwangi and Swallow. 2005).

2.10. Rotation

The northwestern Gujarat state of India, the mesquite had a large percentage of vegetative cover, producing about 25 to 30 tons of biomass/ha/year at a short rotation age of 4 to 5 years (Mwangi and Swallow. 2005). The NAS (1980a) stated that on a 15-year rotation, expected yields were 75–100 MT/ha; 50–60 MT on 10-year rotation; and yields of 5–7.5 MT/ha/year in the Arizona US (James A. Duke. 1983).

2.11. Income / Selling

Mesquite Treat Enterprises reported that mesquite dry wood approximates 3,000 lbs/cord costs about \$100 in Arizona. Selling the log to restaurants 50-lb bags was \$12.50–17.50 for chunks, and \$20 for chips (James A. Duke. 1983).

A study on the costs and returns for mesquite plantings in the semi-arid northeast of Brazil indicated that economic yield was higher than short-cycle crops e.g. mung bean, corn and arboreal cotton. (World Agroforestry Center, 2004).

In the Sudan, The daily fuelwood was often collected in two bundles of totally about 1.8 kg, which had a price of 50 SD (Jörn Laxén, 2007).

2.12. Questionnaire Survey

From each village, six households totally 30 were interviewed on random basis their utilizations and role of mesquite. Almost all the fuelwood used by the households in the dry zone was mesquite from the buffer zone and kept in their yards, which the households either collected themselves or bought locally. Interviews stated their opinion quietly, but some could tell that their answers were sincere (Jörn Laxén, 2007). Women, who depended on it for fuelwood (Mwangi & Swallow, 2005).

2.13. Visions of Rural People

Mesquite's thorn, aggressive habitats such as pastures and irrigation, farming and fishing areas, negative effects on animal and human health by local residents complained (World Agroforestry Center, 2004).

In the Indian province of Rajasthan, local people's perceptions were favorable during the early stages of its introduction. At that time, it was welcomed as a field boundary marker and fuel wood. However, changed later as the negative effects of the invasion of agricultural land, its sharp thorns, suppression of grasses and crops became more pronounced. Livestock keeping view negatively because it invades valuable pastures. Poor population acknowledges its benefits for fuel and fodder (Mwangi and Swallow, 2005). The reference also mentioned that some farmers in the area of Kassala (Sudan) claimed not only costly to clear but also destroyed agricultural crop, thorns are harmful to both farmers and their machinery. Additionally, it consumed underground water, threatening the Beisha oasis in Western Sudan and the plant's pods bring about some animal diseases. In Ethiopia, the aggressive invasion in pastoral areas is displacing native trees, forming impenetrable thickets and reducing grazing potential. Agricultural lands and protected areas such as the Awash National Park are threatened (Mwangi and Swallow. 2005).

Farmers considerably reduced the profits from crop cultivation, due to the increased mesquite fields and for the maintenance of irrigation canals. It also costs for employing

labor for weeding and the cutting of trees, and thorn injuries that sometimes needed medical treatments. Mesquite is actually growing inside the agriculture scheme, which was not a preferred situation. In 1995, Sudan presidential decree was issued for its eradication, which was followed by campaigning for the eradication (Jörn Laxén 2007).

There are many who dislike the genus because of problems of the species as invasive, thorny weeds. These views are common where they have introduced and spread in native ranges. Research confirming allergenic nature of the pollen has led to mesquite not being recommended for urban environments (Pasięcznik *et al.*, 2001).

3. Problem Statements

Fuel wood, fencing, charcoal and can thrive on poor soil, income for selling and using for rural people are as advantages; disadvantages such as aggressive thickets, poisonous thorn, water consuming and decreasing native species were communicated without systematic documents in Myanmar. Its IAS characteristics; likeness and dislike by questionnaire survey on different society such as housewife, farmer, husbandry and forester should be well documented.

4. Objective

To determine *P. juliflora* is invasive alien species or favorable species in Myanmar

4.1. Specific Objectives

- Evaluation IAS characteristics of mesquite focus on GIS distribution, branching, soil & climate conditions, seed germination, chemical composition of thorn and pod
- Survey the responses from rural people whose concepts and attitudes on the mesquite

5. Materials and Methods

5.1. Study Areas

Dry Zone-Prosopis was dry zone species and introduced in the area.

GIS Mapping

GPS (Global Positioning System) was recorded for satellite images of mesquite cover in the dry zone of Myanmar. IRS Liss 3 (India Remote Sensing) 2010 with resolution 24 x 24 meter was application in the Remote Sensing and Geographic Information System (GIS) Section, Forest Department, Myanmar.

On ground Characteristics

- Sagaing Region- 3 villages
- Mandalay Region-3 villages
- Magway Region-3 villages

Staking

20m x 20m existing 4 blocks (East, West, South, North) in each village.

Measuring Population, Height and Branching

Mesquite were counted the population of each block. Randomized 10 trees of each block were recorded their height and branching.

5.2. Meteorological Study

Meteorological data from study areas were obtained from the nearest Meteorology Stations.

5.3. Comparison of the Soil Properties

Soil physical properties were recorded in each study area from township of forest department. Soil chemical properties and P^H were retrieved from research paper of Sann Lwin *et.al*, 1996-1997. Soil types were based on Myanmar Agriculture Service (2010) in this paper.

5.4. Seed Germination

Pods of mesquite from three regions were collected in January 2012, their 100 seeds were mixed and tested 2 times in June and July (rainy season) on the seed bed in the temperature (25- 35 °C) for the germination at the pathology laboratory, FRI.

5.5. Chemical Composition of Pod and Proximate Analysis for Feedstuffs

Pods of mesquite were collected from natural stands for their proximate chemical composition at the HNE Eberswalde Applied Science University of Germany in July 2012 and analysis for feedstuffs of fresh leaves and pods were tested at the University of Veterinary Science; Department of Physiology and Biochemistry, Yezin, Myanmar in April, 2013.

5.6. Chemical Composition of Thorn

Test containing chemical compounds affect poisonous thorns of mesquite at the Medicinal Research Department. Nay Pyi Taw, Myanmar in May, 2012.

5.7. Questionnaire Survey

Respondents from different society: forester, farmer, housewife, and animal husbandry were selected randomly interview 15% of the household. Their usage, likes & dislikes, and visions were mainly targeted in the questions. Three villages were carried out in each region, totally 9 villages were investigated from mesquite growing areas of Sagaing, Mandalay, and Magway Regions of dry zone, Myanmar.

5.8. Data Analysis

Comparisons were conducted for all findings with statistical analysis by SPSS (Statistical Package for the Social Sciences) software program.

6. Results

6.1. Distribution

IRS (India Remote Sensing) Liss3 Satellite Images (2010) mentioned mesquite cover was 6449.15 hectares about 0.2% in 9.8% dry forest of Myanmar. It was growing grouping edge of the villages and roadsides. Mesquite cover in Sagaing, Mandalay and Magway regions were 1237.888 ha (0.013%), 3251.73 ha (0.0857%) and 1959.53 ha (0.044%) respectively.

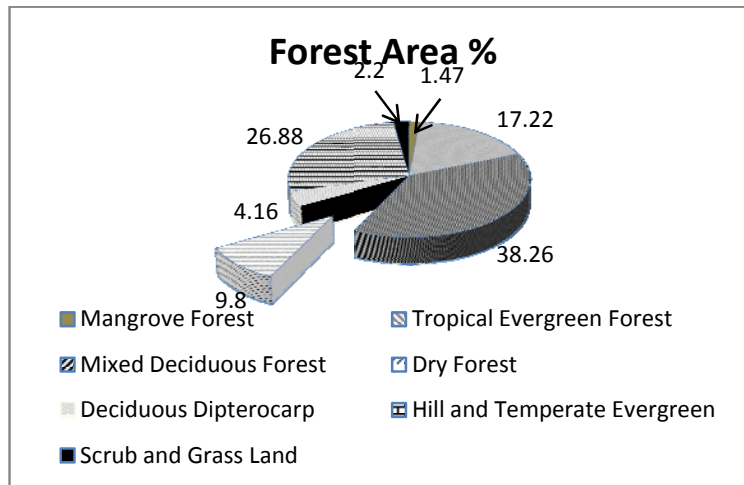


Figure 1. Percentage of Forest Cover in Myanmar

Table 1. Average height, branching and population of *P.juliflorain* nine villages

Region / Township	Village	Height (ft)			Number of Branching			Population in 20 m x 20m block		
		min	max	avg	min	max	avg	min	max	avg
Sagaing/Sagaing	Thitcho Gone	5	18	10.73	2	52	15.75	56	113	78.25
Sagaing/ Shwebo	Ohitkan	2	22	10.03	3	20	7.75	37	60	43.5
Sagaing/Monywa	Neitbanwa	7	18	12.95	2	19	9.68	30	67	45.25
Mandalay/ Mahlaing	Htannpinkan	2	25	11.85	2	35	11.9	23	40	33.5
Mandalay/ Tadaoo	Themaungkan	4	12	8.13	3	36	12.53	50	90	64
Mandalay/ Thazi	HlainngTet	5	21	9.58	3	30	11	41	74	58.5
Magway/Minbu	Ywatha	7	15	18.29	2	50	13.33	13	47	32
Magway/ Yenanchaung	Thone-sett-chauk (36 village)	5	20	10.18	2	34	10.83	36	98	75
Magway/ Pakkoku	Tantkyi	3	20	9.13	2	18	7.63	35	74	56

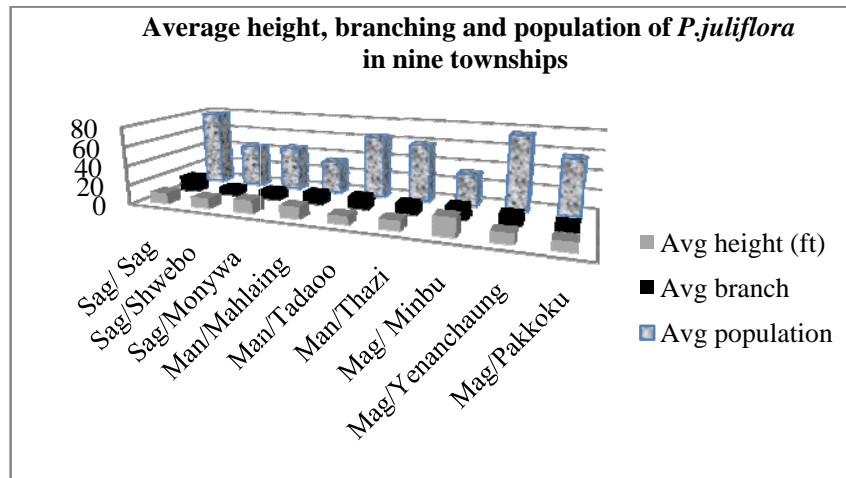


Figure 2. Average height, branching and population of mesquite in nine townships

Regional Analyses

Heights, branching and population were no significant among the three regions in LSD except village vs. villages where had some significant and some highly significant.

6.2. Meteorological Data (2001 to 2010)

Nineteen townships of mesquite growing in dry zone had average rainfall within 10 years (2001 -2010) from 18 to 36. 59 inches (457.2 - 929.4 mm) and six townships had average temperature 15.9 °C to 43 °C according to getting the data collection.

6.3. Soil Properties

Mesquite growing well was found at the soil textures: clay, clay-loam, loam, sand, sandy-loam, sandy-clay-loam, and loamy sand in study areas. Sandy loam was dominant and most were active alkalinity and some was acidity; totalN, P, and K were less than minimum requirements, generally P^H range were 7-8.5 60%, <8.5 30% and > 6 was 10%; some soil profile points were Tatcone (OhnpinDahat Taw, Protection Forest)3.03, Mahlaing (Maenyo, Reserved Forest)=3.83, Salin(Unclassed Forest) 3.87, KhinOo (Road Side)= 11.06; and MohnYwar (BansiKyaukpyinTaung) 11.01 (San Lwin et al 1996-97).

6.4. Seed Germination

Mesquitepods were measured that was 4.5-22.5 cm long and seeds contained 5-32 seeds. Germination was started after 2 days on seedbed and percentages were 58.2 % in June and 73% in July. Highest germination was found after 2 days in July but in June, after 5 days was the highest, and viability was reduced after 10 days and germination became 0 point.

6.5. Chemical Composition of Pod

Table 2. Analysis minerals of Pod & Seed of mesquite

Content Minerals	Contents in % (dry weight of)	Contents in mg/kg (dry weight of)
N	2.37	
C	65.2	
S	1.26	
P	0.448	
K	2.25	
Mg	0.155	
Ca	0.169	
Na		1.573
Al		84.6
Fe		74.3
Mn		nn
Cd		nn
Cr		2.02
Cu		11.3
Pb		nn
Zn		18.6

HNEE University of Sustainable Development. Eberswalde, Germany, July 2012

nn= no result, content is very small

Table 3. Proximate analysis for feedstuffs of Pod plus Seed of *Prosopis juliflora* DC

Sample name	DM %	CP %	OM %	ADF %	NDF %	EE %	Tannin %	Cellulose %
<i>P. juliflora</i> fruit (wet)	91.45	20.23	94.16	33.03	48.76	1.90	1.80	32.42
<i>P. juliflora</i> fruit (dry)	89.91	14.38	95.24	25.49	38.22	3.38	1.36	24.54
<i>P. juliflora</i> leaf (wet)	92.71	25.13	90.30	24.18	31.21	4.56	1.86	23.38

University of Veterinary Science; Department of Physiology and Biochemistry; Myanmar.

April, 2013

DM – Dry Matter

CP – Crude Protein

OM – Organic Matter

ADF – Acid Detergent Fiber

NDF – Neutral Detergent Fiber

EE – Ether Extract

6.6. Chemical Composition of Thorn

Table 4. Phytochemical investigation of thorn of *Prosopis juliflora*

S/N	Test	Thorn
1	Alkaloids	-
2	Flavonoids	+
3	Steroids	+
4	Terpenoids	+
5	Phenolic compounds	+
6	Tannins	+
7	Saponins	+
8	Glycosides	-

Department of Traditional Medicine, Research and Development, Myanmar. May, 2012.

Test Performed - Precipitation reaction and Color reaction

(+) detected

(-) not detected

6.7. Questionnaire Survey

Table 5. Educational level in the community of survey areas

Community	Monastery School level %	Primary school level %	Middle School level %	High School level %	Graduated %
House wife	22.2	50.2	15.5	7.7	4.4
Farmers	25.5	44.6	20	6.6	3.3
Husbandry	26	51	16	4	3
Forester	-	-	5	25	70

The individuals ranged in age from 20 to 80 were interviewed. From age 20 -30 was 10 %; 31 to 60 was 80 %, and 61-80 was 10 % were involved in the interview. In the education levels, farmer, husbandry, and housewife stopped their education at the primary level except forester.

Questionnaire survey on housewife, farmer, husbandry and forester, their likeness of mesquite in three regions were resulted in the following table 6.

Table 6. Questionnaire survey on regional likeness in different society of mesquite, January 2012

Community	Sagaing Region	Mandalay Region	Magway Region	Avg. 3 Regions	Usage
House Wife	71.77*	92 *	72.23*	78.66*	Fuel wood/ Fencing
Farmer	46.67	49.73	39.3	45.23	Fuel wood/ Shade
Husbandry	35.2	50.53	34.9	40.21	Fodder/Shade
Forester	58.93	62.57	52.63	58	Dry zone greening

Significant *

6.7.1 Housewife-their likeness were cutting themselves near their villages and low price if it was bought; and fencing except dislike the thorn of mesquite, juvenile fuel wood were smoking and insect boring. Three regions of likeness of housewife were significant than other societies. Housewife of Mandalay Region had higher likeness. In Magway Region, likeness in Tantkyi village was higher than two villages.

6.7.2 Farmers like it for fuel wood and shade, about 60 years old mesquite had height 25 ft and girth 7 ft found in the Gway Gone village, Yenanchaung Township, if it was not cutting and keeping about 8 years to more. However, they think soil fertile decreasing and yield loss where other plants could not grow well, and difficult to eradicate in their farms, waste the labor charges and time. A farmer from Yenanchaung recommended its growing at the bank of creek can prevent the bank collapse. A man of age 50 whose leg was amputated by infection from mesquite thorn injures. Likeness of farmer of three regions was no significant.

6.7.3 Husbandry dislike because of thorn injury of leg of sheep and goat, the animals cannot diet and weight loss, daily taking out thorn and giving treatment leg or hoof. The price of their animals was go down, for example, selling about 30000 Ks instead of 45000 Ks if the sheep was suffered foot infection and cutting the leg. Their likeness was releasing grazing freely when the food of livestock raring. Regional likeness was not significant.

6.7.4 Foresters were more educated and they want to allow using by rural people as control mesquite extensive distribution and whatever supporting their livelihoods as a little poverty reduction. No significant was found in regional likeness.

6.7.5 The travelers complained whose motor cycle and bicycle were punched a hole by its thorn. Paganis historical, and tourism site, pilgrims and tourists against that thorn puncture their sole of foot, shoes, slippers and bicycles.

6.7.6 Schoolteachers against the mesquite growing near the school who worry for their students to injury of thorn.

6.7.8 Expenditure and Income

Fuel Wood

The villagers usage of mesquite was cut or buy use, and rotation cut at the own land or communal land. Responses of Thitchogone villagers (Sagaing Township, Sagaing Region), that one bullock cart consisting 1.7 metric ton of mesquite wood were sold getting 5000-10000 Ks. Five acres land owner of the village who cut the mesquite wood 3 years rotation and getting income 50,000-100,000 Ks per one time of 10 bullock carts (17 MT). Two acres land owner of Htannpinkan villager (Mahlaing Township, Mandalay Region) also rotation cut 3- 4 years getting about 10 bullock carts had income 50,000 Ks. A housewife had 8 family members usually buy one cart of fuel wood for 2 months. A basket of fuel wood of mesquite was sold 100 Ks for daily use but most of the villagers cut themselves for their kitchen. Villagers cutting themselves and selling at restaurant, bakery, and fry snap shops, their income was 5000 Ks per day that income was higher than other villages of other regions.

Thitcho Gone village (Sagaing Township) had 2.8 MT/ha/yr the yield got income about 80,000-150,000 Ks and Htannpinkan village (Mahlaing Township, Mandalay Region) obtained 4.5 MT/ha/yr, income about 120,000 in 2011.

Mesquite were cut and transported by boat from Tantkyi village of Pakkoku Township, Magway Region where is situated beside of the Ayeyarwaddy river. The boat could carry the wood 1.5 tons and getting income 40,000 Ks for only fuel wood selling, which transported 2 times per month. However, questionnaire survey could not get chance with boat owner that was not enabling to know his income.

In Mahlaing Township, **Toddy Candy** small business used the mesquite for toddy cooking. They bought fuel wood 1 cart had cost 3000 Ks/day, it was cheaper than other villages. The Toddy season was 6 months per year. The candy was produced about 1 viss (1.63 kg) per pan and getting 10 viss per day and 1 viss was sold 500-800 Ks. Their costs and income were general estimation in one day; fuel wood expended was 3000 Ks and toddy candy selling was average 7000 Ks, therefore, profit was about 4000 Ks without estimation labor charges of toddy fluid collection and toddy cooking.

Charcoal makers built the stove were different sizes at the different townships. They cut the wood, built the stove, and baked the wood themselves; therefore, they never calculate labor charges. In the HlainngTet village (Thazi Township, Mandalay Region), their charcoal stoves were small. One stove bunt 3 days long and produced 5-6 bags, one charcoal bag was sold 1000 Ks, and getting 20-25 bags per month that was calculated income 20,000-25,000 Ks per month. In the Htannpinkan village (Mahlaing Township, Mandalay Region) they were getting 20,000 Ks per month from charcoal making when resting their crop-planting period. Charcoal makers cut and baked on the ground, covered with leaves and stem of mesquite on heap of wood without making stove in Themaungkan village (Tadaoo Township, Mandalay Region), baked for 5 days, cooling for 2 days and bring out in one day. One time baking, they got 4 bags and 3 times baked per month, selling price was 1700 Ks for one bag, therefore, 20,400 Ks income within a month. Tantkyi village (Pakkoku Township, Magway Region) made charcoal that income was 30,000 Ks per month.

Villagers of HlainngTett (Thazi Township, Mandalay Region), few mesquite wood were around the **pots** and covered by straw and baked 2 hours. After cooling 10 hours, the pots were taken out, sold about 600 Ks per pot. The pot seasonal business was stopped in the rainy season. The profit was about 1,000,000 Ks in the season (within 6 months) having taken out the expenditures e.g soil, fire wood, labors, and transport.

Kitchen stove baking used mesquite firewood was found in the HlainngTett village. Cost of 1 bullock cart of the fuel wood was 3,000 Ks that baking stove needed 6 carts of wood for two kilns per month. Soil for stove was bought 2,000 Ks per bullock cart, it needed 20 carts for 2 kilns per month thus cost was 40,000 Ks and getting the kitchen stove were 200. Selling one kitchen stove was 700 Ks, average received about 82,000 Ks from 2 kiln per month, however, if it will be calculated the charges of materials, labor and transport, the remaining income would be about 50,000 Ks in a month.

Brick making in HlainngTett village, expenditure for transport was 36,000 Ks for 6 Faw truck cars; 200,000 Ks for soil 100 carts; 500,000 Ks for labor charges of brick mould, 75,000 Ks for putting & firing the brick, and 39,000 Ks for unexpected cost. Profit was about 400,000 Ks per month for one kiln.

1 USD = about 850 (2012)-1000 Ks (2013) (Myanmar Currency Ks. = Kyats)

7. Discussions

7.1. Distribution

Despite of utilizing widely without depletion of mesquite in Dry zone of Myanmar is significant, not similar to other tree species. Where had been already distributed over a large area that is impossible to reverse as previous time.

Satellite images of previous study and other dry zone species: *Acacia arabica*, *Acacia catechu*, *A. leucophloea*, *A. microcephala*, *Terminaliaoliveri*, and *Tectonahamiltoniana* etc. composition are lacking to compare the mesquite cover in Myanmar. The mesquite composition 0.2 % in 9.8% of dry forest is not too much in this result. However, its aggressive distribution can compete with native species and enable to become more than recent percentage if electric and gas may be consumed for all ranks of Myanmar people; mesquite will be neglected. In this study, the results of population; height; and branch were depending on the utilization pressure by population of the village, transport reliability, and income greater, not responsible to real situation of the distribution.

Sagaing Region has the lowest cover of Mesquite although it is the largest region, because its dry zone is smaller than Mandalay and Magway Regions.

After this species invasion, people noticed that their native species were depletion in the decade. Existing dense stands may be thinned and/or pruned, cut stumps for fuelwood, and charcoal products. Recently, the species tolerance, branching, and good natural regeneration is still balancing with usage.

During the early 1990s, Sudanese Government considered mesquite is a noxious weed and a problem tree species due to its aggressive ability to invade farmlands and pastures, especially in and around irrigated agricultural lands (Jörn Laxén, Helsinki 2007). Township Socialism Council (1982) declared to eradicate in some villages of Sagaing Region but other species could not replace and the mesquite had been kept again for fuel wood in those villages.

7.2. Climate

Literatures show rainfall 50-1200 mm was mesquite growing favorable. Myanmar Dry zone is hot almost throughout the year with annual low precipitation between 457.2 to 929.4 mm. which was similar to other literatures. Now mesquite had invaded along bank of Sittaung River, Taungoo Township in 2009 where has higher rainfall 2235 mm and not hotter (21 -38 °C) than dry zone (FD, 2012). That shows the species can thrive at all from faraway of dry zone and alarmed to control its extensive dispersing to everywhere.

7.3. Soil

DZGD (2009) recorded soil P^H was different range with Sann Lwin et al 1996 & 1997. Geological soil types of dry zone Land Use Division, Myanmar Agriculture Service (2010) mentioned that mesquite could grow wide range of soil type. In this study was found more dominated by soil texture sandy loam. In Thazi Township, it was growing in the waterlogged area. Its nature outstanding any soil favorable for growing is not only positive but also negative aspect in prevention of invasion.

7.4. Seed Germination

A forester from Tantkyi Mount who tested the seed germination results was 50% by manual and long 20 days; however, germination was 100 % within 5 days by manure dropping of goat and sheep (AungThanMyint, 2012).

Livestock droppings create good conditions for germination and growth. Therefore, foresters do not want to establish the nursery for mesquite plantation and also they like growing naturally and people using mesquite was automatically control their aggressive distribution without costing and wasting the time. Livestock grazing of the pods was as a control its dispersal of seeds, on the other hand, that seeds were promoted for germination by partial digestion, and dropping is considered for potential of arriving to new areas.

7.5. Pod (Fruit)

In Myanmar, mesquite forage was no record feed intake daily of free grazing by goat and sheep. In this experiment, analyzed K 2.25 was suitable amount, N and CP (table 2 & table 3) were not too difference contents, but, S was six fold more and Ca:P (1:2) was opposite ratio to the literature. However, nutrient requirements for sheep and goat will vary by the age, weather, shelter, activity, and body condition ([www.SHEEP 201. Info/201/nutrition.html](http://www.SHEEP201.Info/201/nutrition.html)). Therefore, these findings could not be compare to literatures of oversea as well as local literature was lacking. Feedstuffs and minerals of dry pod of mesquite were consisted with suitable composition for sheep and goat except S, Ca, P, and some was a few more or less than other pasture vegetative (Personnel Communication, Lecturer, University of Veterinary Science, Yezin, 2012).

Mesquite can be a valuable fodder source especially during times of drought. Unconfirmed reports that goats regularly feed mesquite pods suffer their teeth fall out cause of sugar content (World Agroforestry Center, 2004). In this study, the teeth problem of cattle was not questioned in husbandry survey. Mixing other diet intake and control free grazing of green immature pods is necessary to be aware of the amounts that can be fed safely and healthy.

The essential minerals for sheep and goats were observed in the pod of mesquite (table 2). But, the minerals Cl, I, Mo, Co, Se, Fl were not found, there are not exact requirements and need low range in the diet if they are more which will be toxic (Anon, 2012). Mn in Pods of Myanmar was not observed, but it was contained in the Alli et.al, 1987.

7.6. Thorn

Literatures about chemical of thorn were not found for reviews. Length of thorn was about 1 inch. Phytochemical investigation (table 4) indicated as typical. Flavonoid and Phenolic compounds usually consisted in almost of plant materials and they have pharmacological properties. Steroid is either medicinal or a toxic compound. Terpenoids also can be found mostly in the essential oil and oleoresin, some Terpene is to be toxic, allergic, and pain. Some Tannin is toxic and some is non-toxic. Harmful and useful compounds are consisted in the Saponin (Personnel Communication, Chemistry Section, FRI, Yezin, 2012). Therefore, the analysis cannot be concluded definitely which composition of thorn is harmful or not; chemical screening was constraint by budget and technology. Chemist should screen in detail its composition.

7.7. Questionnaire Survey

Responses of the individual were harvesting for home use and sell almost were fire wood. Housewife harvesting themselves assumed to cover their daily expense account for household. The fencing was found in their yards and livestock farms renew every year. All people highlighted the thorn is a major problem causes of sharp, strong and poisonous. In some cases, if untreated infections may suffered amputation of limbs of their livestock and some people.

Farmers claimed that mesquite affect leading to a drying up of water scarce environment and noted the problem to be reduction of pastures for livestock grazing, and reduced farmlands for cultivation.

Fodder cost was covered by free grazing. Not all individual could estimate the amount of pods consumed by their livestock; they like big stand of mesquite that provide sufficient shade for placing their animals.

Foresters likeness was the species could grow on poor soil and for dry zone greening, however, they rejected to establish as a man made plantation, their reason was that species could be able to grow and distribute naturally and easily; why waste of the money, time and effort.

The all market situations in the villages were too complex to be calculated. The village Themaungkan (Tadaoo Township, Mandalay Region) was higher likeness than other villages because it is growing well near the village, easy for transport to near city and in addition, they have skill in cutting of wood and making of charcoal.

NAS (1980a) stated that on a wood yield of 5-7.5 MT/ha/yr in the US (James A. Duke. 1983). The yields of Myanmar had less than the US, however, the income of wood was not mentioned in the literature, and period was different to compare with Myanmar.

Some villagers were working as a part time cooking the toddy candy when its production period, as a family business at their own land of toddy field. It was difficult to estimate the budget of income because their costs and toddy market were not stable in the villages. They never record systematically their cost and income that seems daily working and daily expenditure for their livelihoods.

Charcoal making was in the resting planting period. Interviews were carried out with fuel wood seller, charcoal maker, brick maker, and toddy candy maker. Their numbers were low in each village thus answers could not be calculated by statistical.

Pollen from mesquite is cause of allergy and asthma but in this study nobody seem noticed the health problems. Information from bee-keeper of Myanmar, that mesquite flowers are a valuable source of bee forage (Personnel Communication, Bee Department, 2012).

Some do not want to answer either shameful or afraid, some are knowledgeable and willingness. Fuel wood of mesquite was seen as a heap in their yard although some replied they do not use mesquite. Township forester along with researcher for interview; the respondents careful their answers avoid hurting their livelihood such as cutting; utilizing, making char coal and trade without license and tax. It should allow cut for fuel wood with rotation and force transport legally and selling by forester.

Recently, it would be keep as an essential species to solve the firewood problem of dry zone for rural people. However, long-term investigation is necessary such as positive and negative impacts more by multiple viewpoints.

8. Conclusions

Prosopis can be stated an invasive species in Myanmar also as international commitment for its invasive characteristics such as thrive at all from faraway of dry zone; branching; population; tolerance seed germination; outstanding any soil favorable for growing; difficult to eradication and all people highlighted the sharp & poisonous thorn. However, it is assumed that fuel source for livelihoods of rural people and a substantial cash income for landless population in the some areas of dry zone.

Survey the responses from rural people whose concepts and attitudes on the mesquite;

"like it for no choice" is absolute proper answer for dry zone people.

9. Recommendations

Decision-makers need to justify and compare the benefits and detrimental for the people and environment. Need early detection prior to epidemic outbreak in a new area and precaution is important prior to introducing a new exotic species. It is difficult to predict which species should be introduced, and may become invasiveness or not. However, information from database and websites are available easily and readily in these decades as a valuable tool and discuss with academic group for decision before introducing of a new exotic species.

A small piece of root can be re-survive and difficult to eradicate. It requires completely eradicated in the unwanted areas such as Airports, Monastery and Buddhist Temple yards, and School -yards, historical and tourism site of dry zone.

Native dry zone species e.g. neem, tamarindus, albizia, acacia, ziziphus, and medicinal plants would be appreciate to cover the mesquite extreme distribution although they are growing slowly where. Thorn-less useful species or another adaptable to such site would be substitute in the dry zone.

Training of effective charcoal making for rural people are necessary because secretly with ineffective traditional method was found in the field trip.

A thorough understanding of the relevant issues such as; soil and nitrogen fixing nodules, wood utilization, health problems from pollen, poisonous thorn chemical screening, animals feeding and nutrient gain, carbon storage, etc. should be studied with experts in such fields. It is better, based on not only one's findings but also multiple points of views would lead by sectional expertise.

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