ADDIS ABABA UNIVERSITY

FACULTY OF VETERINARY MEDICINE



# LANTANA POISONING IN TWO ADMINISTRATIVE AREAS OF EASTERN ETHIOPIA

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By

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| | |
|---|---|
| Mg | Milligram |
| Kg | Kilogram |
| GIT | Gastro intestinal tract |
| Var | varieties |
| AVIS | International veterinary information service |
| Fig | Figures |
| QGNRM | Queen Land Government Natural Resource Mine |
| PA | Peasant Association |
| HBCO | Harar Branch Coordination Office |
| PACE | Pan African Programme for Control of Epizootic |
| BDRDAB | Babile District Rural Development and Agriculture Bureau |
| PCV | Packed cell volume |
| NGO | Non governmental Organization |
| GO | Governmental Organization |
| HE | Haematoxylene eosin |

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## ABSTRACT

A study was conducted to determine the effect of lantana poisoning in eastern Ethiopia by the use of clinical survey, questionnaire survey and controlled experimental trial. For the clinical survey, information were collected through interview, inspecting the clinical signs, gross and microscopic lesions, distribution & availability of the plant.

An overall clinical prevalence during the dry season was 16.7% and was found to be significantly higher in Harari Region (29.5%) compared to Babile district (8.7%). Furthermore, prevalence rate (39.9%) in Erer valley was significantly higher compared to other area (1.5%). Sex on the other hand seems to have no impact on the effect of lantana poisoning in the study area. The experimental trial involves two artificially challenged experimental groups, each with seven sheep and ten goats and matched control group without exposure. The trial demonstrated that lantana species prevailing in the area are toxic to sheep and goat at a dose rate of 40g/kg body weight.

Clinical signs manifested by experimentally intoxicated poisoned sheep and goats include depression, decrease appetite, static rumen, jaundice, photosensitization, and dehydration with firm dry feces and or diarrhea with deep yellow color urine. The clinical symptoms and post mortem lesions diagnosed at field during clinical survey were quite similar to signs exhibited by experimentally intoxicated goats. The only exception was secondary complication that usually masks the primary cause in naturally intoxicated goats.

This study has demonstrated that lantana has been spreading and infesting the vast area of eastern highland. From the study area alone, about 102,500 hectares of bush and shrubs land were infested. However, not all aspects of lantana are harmful: it serves as a source of firewood, serves as medicinal plant, for cleaning plastic cans, and to build fences around farm boundaries and encampments.

In any case, the harms that lantana infestation entails outweigh its beneficial traits. The community is expected to accept this fact and commit itself to manage and control lantana from infesting new area.

# 1. INTRODUCTION AND OBJECTIVES



## 1.1 Introduction

The genus lantana consisting of over 160 species, is a member of the family *Verbenaceae*. However, the term "lantana" describes an aggregate species, *Lantana camara*, which contains several hundred wild and cultivated forms or varieties. Twenty-nine taxa of *Lantana camara* have been identified in Australia state alone and at least 19 of these are toxic. The toxic compound is triterpene acid, the major toxins being lantadene A and lantadene B (Seawright and Hrdlicka, 1977). Australia's first record of lantana was in 1841 at the Adelaide Botanic Garden (Swarbrick *et al*., 1998). By 1897, lantana had become a huge rambling shrub and a most troublesome weed, which had spread to form ''impenetrable thickets'' on the banks of streams, deserted farms and the edges of scrubs. Lantana currently covers more than 4 million hectares across Australia (Johon *et al*., 2001).

Lantana is listed as one of the worst weeds in the world: had infested millions of hectares of natural grazing land especially in Asia and Africa, it has become a major environmental weed, invading areas of native vegetation to the exclusion of native plants. It is a weed in 14 major crops including coffee, oil palms, coconuts, cotton, banana, pineapples, sugarcane, sandalwood, tea, rubber and rice. In Hawaii, several hundred thousand acres of cropping lands have been infested with lantana (Ramey, 1999).

*Lantana camara* is also an important weed of agriculture and forestry, encroaching on plantations, orchards and on pastures, where it forms dense thickets that livestock cannot penetrate. In warm regions, lantana provides breeding places for diseases, detrimental animals and insects, including the tsetse fly. The leaves are toxic when ingested by most domestic livestock or native mammals, although toxicity varies greatly between strains (Iea & Tutt, 1998; Johnson & Jensen, 1998; Tokarnia *et al*., 1999). Of the 29 named races in Australia, 19 are toxic or gravely pestiferous (Morton, 1994).

In attempts to control *L. camara*, 38 different species of biocontrol agents have been released in 29 countries. Several of the most effective control agents are seed predators, as *L. camara* reproduces primarily through seed rather than vegetative (Broughton, 1999). However, the degree of control achieved varies greatly according to local climate and the strains of *L. camara* that are present, and in many regions control agents of *L. camara* have little effect. Twenty-eight biocontrol agents have been introduced to Australia, but lantana is still spreading, covering c. 40 000 $km^2$, and is still spreading (Anon., 2000). Some National Parks, such as Forty Mile Scrub NP in north Queensland, are more or less entirely covered with *L. camara* (Fensham et al., 1994). Each year an estimated Aus$10 million is spent on control, and the losses to the livestock industry alone are estimated at Aus$7.7 million, through decreased stocking densities and deaths of over 1500 cattle per year through *L. camara* poisoning (Anon., 2000).

This ornamental shrub contains lantadene A, and other compounds that irritate the mucosa of the gastrointestinal tract. All parts of the plant are quite toxic, and poisoning may occur year-round (Aluja, 1970). Ingestion of 340 – 453 g of leaves causes liver and kidney damage, photosensitization, intestinal hemorrhage and paralysis of the gall bladder (Morton, 1994). Poisoning occurs when clippings are thrown into the pasture. Sheep, cattle, horses, and humans are sensitive to the effects of the plant. Cattle are most often affected. Eating the berries has poisoned children (Johne *et al.*, 2002).

*Lantana camara* has been responsible for poisoning stock in various parts of the world. Cases have been reported from Australia, Brazil, India, and Mexico where it has been shown that the plant is responsible for a condition known as Beach disease (Aluja, 1970). Kumar and Rohatgi (1999) reported that the severity of the lesion depends on such factors as starvation and dehydration.

"Beach sickness" is a name given to lantana poisoning at Gulf of Mexico that is characterized by cutaneous lesions (erythema, necrosis), which becomes worse when exposed to the sun; other manifestations are rumen paralysis, severe constipation, icterus, anorexia, polyurea, emaciation and high mortality (Dealuja et *al.*, 1970).

Since its introduction and distribution, lantana has been spreading and infesting the whole eastern highland of Ethiopia. From 49,250 cattle reared freely in high lantana infested area of eastern Hararghe Zone, 18, 345 were found exhibiting clinical sign of lantana: Of these, 26.3 % were reported dead (Fig. 3) during the study period indicating the severity of lantana poisoning in the area (Shiferaw, 2001). The same study indicated that lantana is not native to the area and has been introduced in the past 40-50 years, as a garden flower or hedge plant. Farmers explained that the plant was detected primarily in towns and later spread to surrounding hills and nearby farms. A traditional production practice, recurring draught and abundant vegetative lantana were supposed to have triggered poisoning that ended up with substantial crises in the pastoral livestock production in the area.

Lantana continues to be used extensively in public gardens from where it is spread by fruit-eating birds and animals. It is very widespread in the country. Nevertheless, neither control measures nor preventive strategies were developed and it continues to become an animal health threat in the area. Lantana poisoning in cattle has been described by several workers from different countries (Seawright and Hrdlicka, 1977; Swarbrick *et al.*, 1998; Tokarnia *et al.*, 1999) and Eastern Ethiopia (Shiferaw, 2001). The condition in small ruminant is however poorly explained.

For this reason, this study was conducted in two administrative districts of eastern highland, namely Harari region and Babile district using goats for clinical prevalence study. and sheep and goats for experimental trial.

**1.2. Research goal**

The ultimate goal of the current research work is to raise public and professional awareness regarding the emerging phytotoxicity problem in the country through provision and documentation of basic data on the impact of lantana poisoning in traditional livestock management. This would ultimately contribute towards the national food self-sufficiency by enhancing livestock production and productivity through provision of basic data on importance of *Lantana camara* poisoning and its impact on prevailing livestock production practice.

**1.3. Specific objectives**

- To determine the extent and magnitude of lantana poisoning as an animal health threat through clinical prevalence study and interviewing herdsmen.
- To characterize the disease condition in experimentally challenged sheep and goats from study area.
- To identify different species of lantana and their distribution in the study area.

## 2. LITERATURE REVIEW



### 2.1.The plant

#### *2.1.1 General description*

Lantana has many common names in different part of the world including cariaquillo, filigrana, mille, fleurs, sauge, red sage, yellow sage, prickly sage, and lakana (John, 2001). Different ethnic groups found in eastern part of Ethiopia call it by different local names. Among Oromo people, it is known as ''beke-arkete", a name expressing its capability to grow in wide agro-ecological zones; in Amharic it is called "yewef-kolo" meaning feed for birds; in Somali ethnic group, it is referred to as "geti" meaning bushy plant (Shiferaw, 2001).

Lantana is a multi-branched shrub forming thickets 2 - 4 m high but capable of climbing up to 15 m with the support of vegetation. It has a shallow root system containing a short taproot with laterals branching out to form a root mat. The leaves are bright green on the upper surface, pale and hairy on the underside; the margins are toothed. The leaves and stems have a strong aromatic odor when crushed.

Flowers form dense clusters and vary in color from red/yellow, orange/pink and white depending on the type, maturity and location. Flowering occur when soil moisture, high air humidity and high temperatures prevail, allowing almost year-round flowering and fruit production in many areas. Flowering will also generally occur 4-6 weeks after a 25 mm rainfall event. Insects with a long proboscis such as butterflies pollinate the flowers. About half of the flowers will develop a single-seeded fleshy berry, borne in clusters, that turn from green to shiny purple/black when ripe (John, 2001).

#### *2.1.2. Ecology and distribution*

Lantana is native to coastal areas of the United States from Georgia through Texas and from northern Mexico to South America including Brazil and Peru and probably Bolivia, Paraguay and northern Argentina. During the last century it has naturalized in most suitable habitats in tropical and subtropical Africa, Asia, and Australia, most of the world's tropical and subtropical islands (Morton, 1994).

Lantana grows on all types of well-drained soil in areas that receive from about 250 mm to 2900 mm of rainfall. It resists drought very well and tolerates salt spray. Aerial portions of the plant are killed by temperatures of $-2^{0}$C, but quickly grow back (Anonymous, 2000). Large and vigorous plants survive firing and cutting, although less vigorous plants are often killed. Lantana thrives in warm, high rainfall, environments where it grows along forest edges, penetrates disturbed rainforest and invades open eucalyptus woodlands, tree plantations and pastures. It does not tolerate water logging, salinity, prolonged drought, or shading by taller evergreen plants. The shoots are frost sensitive and temperatures below $5^{0}$C prevent lantana growth. Rich volcanic and well-drained clays are ideal soils for lantana but it will grow in sandy soils if there is adequate soil moisture (John, 2001).

### *2.1.3. Reproduction*

The inflorescence is a capitates, many-flowered head. The corolla may vary widely in color depending on the variety but characteristically changes colors between the center flowers and older outer flowers. Lantana blooms almost continuously under favorable conditions. Somatic chromosome numbers of 33, 44, and 55 were recorded in India, the later tetraploid being the most common (Sinha *et al.*, 1995). Insects, especially butterflies, pollinate the flowers.
The fruits are blue black when ripe and contain one seed each. Lantana is spread mostly by fruit-eating birds, and some animals, which void the seeds in their droppings. Activities that increase light intensity and soil temperature stimulate the germination of the deposited seed (John, 2001).

Lantana often dominates the secondary succession since allelopathic chemicals released into the soil prevent the germination and competition from some other plant species. Lantana plants can also reproduce vegetatively, sprouting from stems that take root, by layering, or by planting woody cuttings into moist soil. Under suitable conditions of warm temperatures and high rainfall, lantana is long-lived (John, 2001).

### *2.1.4. Benefits*

Lantana, in many horticultural varieties, is planted as a flowering ornamental plant in many countries of the world. It grows as an annual bedding plant in temperate areas. Lantana oil, an aromatic mixture that varies by local plant variety, is exported from at least Brazil. In herbal medicine, infusions of the leaves and other plant parts are used as an anti-inflammatory expectorant, and added to baths as antirhumatic, although medicinal use is not well advised due to high toxicity (Johone *et al., 2002*). Extracts of lantana leaves have shown strong insecticidal and antimicrobial activity in numerous experiments. Research has been made to use this non-leguminous hedgerow weed for mulching crops and five tones per hectare of leave was found to double and occasionally triple the crop yield (Stella *et al.,* 2000).

Although of inferior quality because of size and form, lantana stems are widely used as fuel in less developed countries (Johon, 2001). In Ethiopia this thorny bush is used as firewood for home consumption and fence around encampments and farm boundaries. Farmers consider this plant a reliable fence because it is thorny, easy to propagate, perennial in growth, unpalatable to animals and fast growing ability. These attributes probably enabled the plant to dominate other vegetation (Shiferaw, 2001).

### *2.1.5. Plant varieties and toxicity*

Lantana is constantly evolving through commercial introduction or breeding of new varieties. The new varieties add genetic diversity to the weedy forms, potentially increasing their weediness, and compromise the potential for future biological control. There are now reputedly over 650 forms or varieties worldwide. These varieties differ in flower color, hairiness of leaves, spiny stems, toxicity and growth. Some of these varieties are hybrids, crosses with other lantana species (John, 2001).

Horticulturists have developed varieties that are largely sterile, however, these can produce viable pollen and occasionally seeds; they also spread vegetatively (Ramey, 1999). The 'sterile' forms of lantana is an aggregate species that no longer genetically match the lantana found in its native range, due to both natural and horticultural hybridization. Interbreeding between naturalized and commercial forms will continue to produce new genetic varieties. Consequently, new forms are becoming increasingly dissimilar to the original parent plants by evolving in (John, 2001).

Three taxa of the lantana plant (*Lantana camara var. aculeata)* - I (white-pink), II (yellow-pink), and III (yellow-red) - differed in the content of lantadene and other compounds (Table 1). Ingestion of lantana leaf powder of taxon III by male guinea pigs caused severe hepatotoxicity. Taxon I elicited mild hepatotoxicity in one out of six animals while taxon II was nontoxic (Vaid and Sherma, 1991).

**Table 1. The toxicity of lantana biotypes (QGNRM, 2001).**

| No | Color of flower | Toxicity |
|---|---|---|
| 1 | Pale pink – pink flowered forms | |
| | Townsville red-centered pink | Very toxic |
| | Small-flowered red-centered pink | Toxic |
| | Mackay red-centered pink | Toxic |
| | Rockhampton red-centred pink | Toxic |
| | Pink minnie basil | Toxic |
| | Helidon white | Toxic |
| | Coolum pink | Toxic |
| | Bundaberg small-flowered pink | Non-toxic |
| | Bundaberg large-flowered pink | Highly-toxic |
| | Common pink | Non-toxic |
| 2 | Red flowered forms | |
| | Proserpine pink edged red | Toxic |
| | Balnagowan pink-edged red | Toxic |
| | Common pink-edged red | Very toxic |
| | Stafford red | Toxic |
| | Round red | Toxic |
| 3 | Orange Flowered forms large-flowered orange | |
| | True orange | Toxic |
| | Townsville prickly orange | Non-toxic |

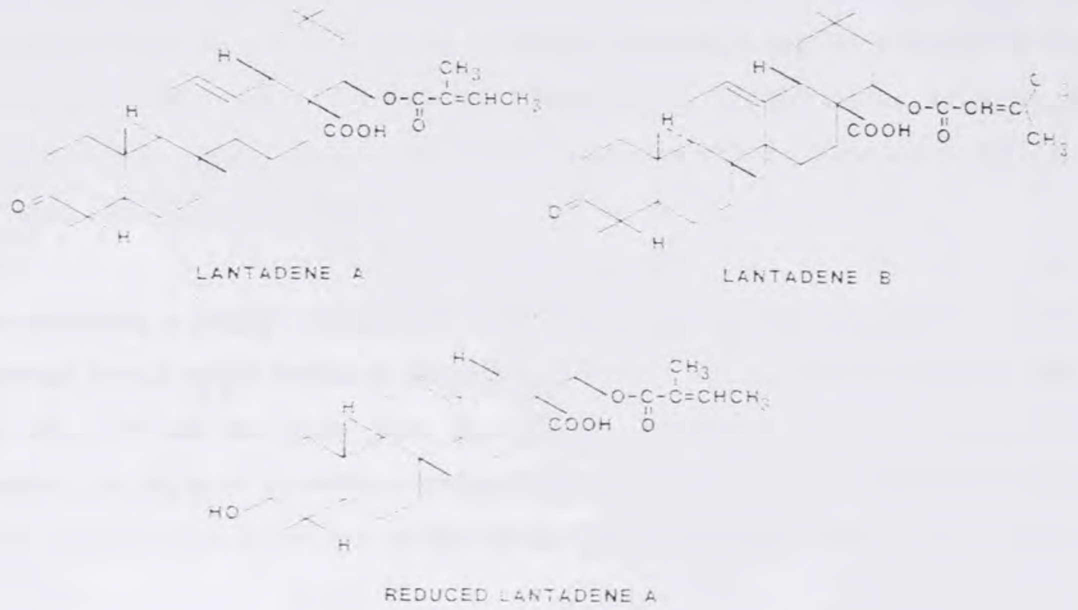
### 2.2. Epidemiology

#### *3.2.1. Toxic compound in the plant*

*Lantana camara*, that grow in Australia, contain triterpene acids. This includes lantadene A, reduced lantadene A and Lantadene B, which were toxic when dosed orally to sheep at doses of 65-75, 42-80 and 200-300 mg/kg body weight respectively (Seawright and Hrdlika, 1977).

Experimental lantana poisoning was induced in buffalo calves by oral administration of dried leaf powder at a dose of 4 g/k body weights. The animals exhibited all the typical symptoms of lantana toxicity (Mandial *et al.*, 1998).

**Fig. 1 Toxic triterpene acids of lantana (Pass, 1986)**




Pink-edged red flowered lantana leaf contains about 1.5% of the dry weight of lantadene A, the most significant toxic principle in the plant. A demonstrably but not fatally toxic dose of the dried leaf of this plant for a 30 kg sheep is about 124 g. Reduced lantadene A, because of low concentration in the leaves (5% of lantadene A) and lantadene B, because of significantly lower toxicity are thus unlikely to be of much importance in poisoning ruminant following consumption of the plant (Seawright and Hrdlika, 1977).

The dried and powdered leaves of *L. camara* by stomach tube at doses of 6, 8, 10, 12 and 15g/kg, given within one day for rabbits produce symptoms discrete to slight that is similar to natural poisoning. Dried *Lantana camara vr. aculeata* collected at State of Rio de Janeiro, was shown not to have lost its toxicity at least up to one year after the plant had been harvested and kept in cloth sacs at room temperature. Both the fresh and the dried plant caused severe disease characterized by photosensitization and death of all animals at the dose of 40 g/kg, given at once; doses of 10 g/kg/day given during 4 consecutive days (Briton and Tokarina, 1995).

### *2.2.2. Predisposing factors*

Many lantana varieties are poisonous to livestock. However, most cases of lantana poisoning occur in stock newly introduced into areas infested with toxic lantana, since stocks bred on lantana-infested area avoid lantana unless forced to consume by lack of palatable pasture. At times of drought, animals may take in large quantities sufficient to produce toxic effects. The morbidity rate with this plant is often high and the majority of affected animas die (Seawright and Hrdlika, 1977). Young animals introduced to lantana infested area are at high risk (Johone *et al*, 2002).

Lantana poisoning is mostly associated with the amount of toxic plant ingested. All factors that increase access to and intake of this plant will make the disease severe. As a result, animals that ingested this toxic plant in sufficient amount can develop the disease. Furthermore, the degree of starvation, transport stress, duration of time of exposure and thirst are related directly with the severity of the disease (Seawright and Hrdlika 1977; Shiferaw, 2001).

In previous study (Shiferaw, 2001), it was demonstrated that cattle were reluctant to browse this plant unless starved. In early mornings of long dry seasons cattle used to browse very small amount of this plant and often prefer *Cactus* if the problem worsen; lantana is the last feed choice for cattle in the area. Camels used to brows this plant greedily but were not observed falling sick. Goats used to pick the seeds, preferably ripen ones, of this plant frequently. However, there was no report of gross visible changes on the health under this environment. Children also eat ripen seed of *Lantana camara* without demonstrable ill effect.

### *2.2.3. Host range*

Lantana leaves contain poisonous substance that causes death in horse, cattle, sheep, goat and rabbit (Morton, 1994). Fourie (1987), reported an outbreak of acute *Lantana camara* poisoning that killed 10 of 91 exposed cattle in South Africa. A comparative study involving experimental poisoning of cattle and sheep with the plant collected from the same place showed that sheep were as sensitive as cattle, which are the main victims of the natural poisoning by lantana (Briton and Tokarina, 1995).

Three red Kangaroo developed the clinical symptoms following exposure to *Lantana camara* leaves mixed with feed (Johnson and Jensen, 1998). Similarly, the powder of dry leaves suspended in water at the dose of 125 and 250 mg produced toxic symptoms in buffalo calves. There was not much difference in the type of symptoms in the animals receiving 125 and 250 g powdered dry leaves, but the death was earlier in the latter group of animals (Dhillon and Paul, 1971).

### 2.2.4. Epidemiological importance

The study conducted on the incidence of lantana poisoning, its effect on survival, growth and fertility rates for seven years indicated that *Bos taurus* Hereford lines had higher incidences of poisoning and higher mortalities after poisoning than the *Bos indcius* based breeds. The same study has indicted that live-weight gains of poisoned cattle of all breeds were reduced but subsequent recovery was rapid. Lantana poisoning had no detectable effect on fertility irrespective of breed, if exposures occur 10 months prior to their first mating (Frisch *et al.*, 1984).

The results of experimental poisonings with *Lantana camara*, indicated that wildlife can be poisoned by both plants and their extracts although the co-evolution of wildlife and toxic plants has resulted in an increased resistance to these substances as compared to domestic animals (Basson, 1987).

**Fig. 2 Mass death of cattle following *lantana camara* poisoning (Shiferaw, 2001).**

The outbreak in eastern Ethiopia caused an overall morbidity and mortality rate of 37.3% and 26.3% respectively. Morbidity rates observed in old age group (>8 years)and young animals less than 2 years of age were higher when compared to other age group (table 2). Mortality rate recorded in these age categories were similarly high when compared to other age groups). This might be attributed to the fact that in young animals the capacity to detoxicate and eliminate toxin is not fully developed, moreover, nutritional requirement for growth might be higher. Aged cattle have a lowered general resistance (Shiferaw, 2001).

As depicted on Table 3, morbidity rates of 36.8% and 37.3 % were recorded in male and female cattle respectively. Mortality rates on the other hand, were 24.7% for males and 26.6% for females. It seems that sex had no impact on morbidity; both sexes were equally affected ones they got access to the poisonous plant. Mortality in female was slightly higher than in males. This might be associated with pregnancy in that, pregnant females' feed requirement is higher and thus they might consume excessive amount than males (Shiferaw, 2001).

Table 2. Morbidity and mortality rate of lantana poisoning in various age group (Shiferaw, 2001).

| Age category | Number of cattle exposed | Morbidity rate (%) | Mortality rate (%) | Case fatality rate (%) |
|---|---|---|---|---|
| <2 | 184 | 41.85 | 32.608 | 77.92 |
| 3-4 | 584 | 35.62 | 20.547 | 57.69 |
| 5-6 | 555 | 33.87 | 20.720 | 61.17 |
| 7-8 | 607 | 33.77 | 25.535 | 75.61 |
| >8 | 430 | 46.74 | 39.534 | 84.56 |
| **Total** | **2360** | **37.25** | **26.271** | **70.53** |

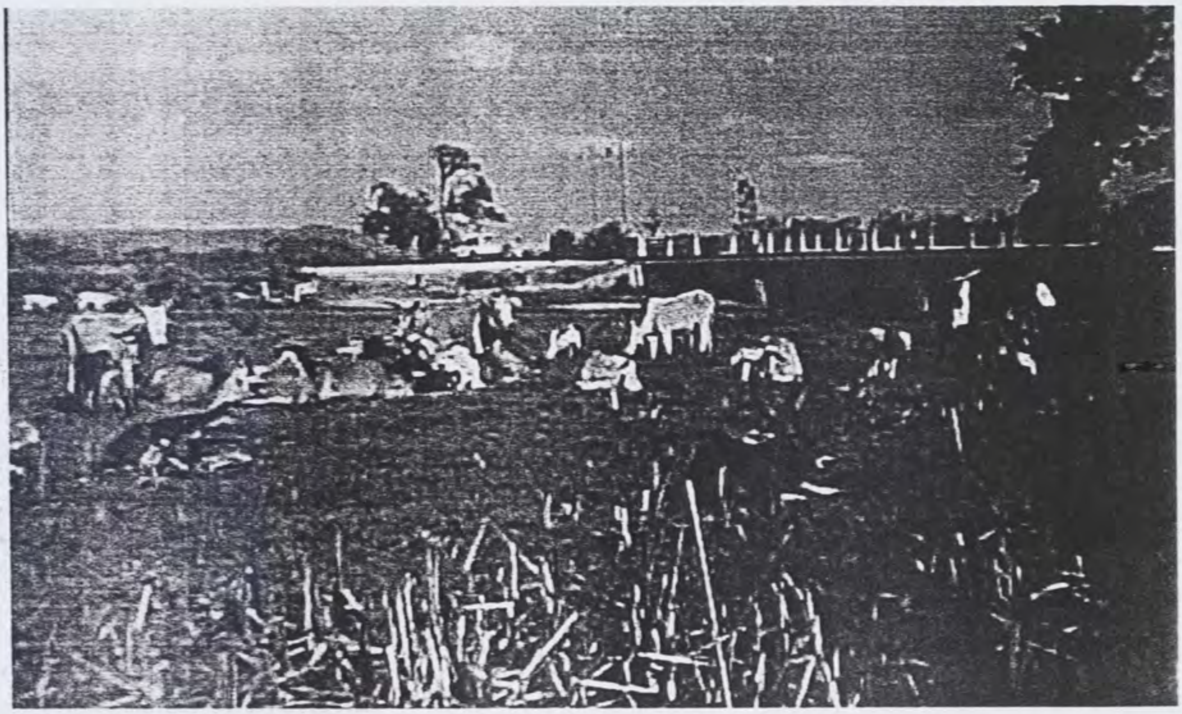


Fig.3 Lantana poisoned herd that lost 11 heads of cattle at Erer valley (Shifersw, 2001).

**Table 3. Sex dependent morbidity, mortality and case fatality rates (Shiferaw, 2001).**

| Sex | Number of cattle exposed | Morbidity rate (%) | Mortality rate (%) | Fatality rate (%) |
|---|---|---|---|---|
| Male | 397 | 36.78 | 24.68 | 67.13 |
| Female | 1963 | 37.34 | 26.56 | 71.22 |
| **Total** | **2360** | **37.24** | **26.27** | **70.54** |

## 2.3. Pathogenesis

Pathophysiologies of lantana poisoning which are important in determining the onset and progression of disease have been identified. Toxic dose of triterpene acids is absorbed from GIT: continuous absorption of toxin is necessary for a disease to develop and be maintained. Ruminal stasis result in retention of toxin in the rumen, this prolonged absorption of toxin from the rumen maintains liver injury and injured bile canalicular membrane may further transmit toxins (Pass, 1986).

### *2.3.1. Absorption of lantana toxin*

Triterpene acids can be absorbed from all regions of the digestive tract but most rapidly from the small intestine (Pass, 1986). They are transported from the intestine in the portal blood to the liver where they are taken up into hepatocytes. Exposure of liver to the toxin triterpene acids is maintained by continuous absorption, mainly from the rumen, as a result of retention of toxic ingesta for several days (Pass, 1986, McSweeney and Pass, 1983).

### *2.3.2. Rumen stasis*

Decreased rumen motility is observed in lantana-poisoned animals and is important for progression of the disease (Pass, 1986). Ruminal stasis appears to be due to two influences. First, lantana-poisoned animals do not eat and this decreases rumen motility. Lantana poisoning also decreases the strength of muscle contraction. The second factor that inhibits ruminal contraction is an inhibitory reflex initiated from damaged liver. It has been demonstrated that sectioning the hepatic nerve converts the pattern of ruminal stasis in lantana poisoned animals

The effect of poisoning by the plant *L. camara* (red sage) on reticulo-ruminal motility indicated that there is a marked decrease in forestomach motility 4-6 h after dosing with the plant and motility continued to be depressed throughout the course of the disease. The effect of lantana on motility is further characterized by a decrease in the number and median amplitude of fore stomach movements. This is in contrast to the effect of starvation, which decreases only the number of forestomach movements, and even this effect was less severe than in lantana-poisoned animals. The effects of lantana on the components of the reflex, which controls rumen motility were examined, however, no evidence was found for a direct effect of lantana toxins on the stretch and tactile receptors in the reticulum, on the vagus nerves, on the gastric center or on the muscle of the forestomach (McSweeney and Pass, 1983).

Evidence was found to support a hypothesis that stasis of the rumen in lantana poisoning is due to inhibitory influences arising from the damaged liver. The evidence showed correlation between the onset of ruminal stasis and liver injury, a relationship between the severity of liver injury and ruminal stasis and the finding that denervation of the liver converted the pattern of forestomach movements in intoxicated animals. Evidently, stasis of the rumen in lantana-poisoned animals is due to at least initially, to inhibitory neural impulses arising from the damaged liver (McSweeney and Pass, 1983).

Rumen liquor analysis of *Lantana camara* intoxicated buffalo calves revealed complete absence of protozoan motility and concentration; the glucose fermentation test value and total volatile fatty acid concentration decreased significantly. However, rumen pH (8.16|0.18) and ammonia nitrogen concentration (27.33|2.05 mg/dl) increase during the toxicity. It was concluded that *Lantana camara* var. *acculata* causes gross rumen microbial inactivity in buffalo calves (Mandial and Randhawa, 1998).

The effects of lantana poisoning on the microbial populations of the rumen and on fermentation within the rumen indicate that lantana toxins do not affect rumen microorganisms directly; the changes observed in lantana-poisoned animals are probably due to anorexia and rumen stasis (McSweeney *et al.*, 1983).

### *2.3.3. Cholestasis*

Intrahepatic cholestasis of lantana poisoning can be produced experimentally by giving lantadene A orally or by giving small intravenous dose at regular intervals (Seawright and Hradlicka, 1977; Pass, 1986). However, if large doses of lantadene A and B are given intravenously, hepatic necrosis occurs. It appears, therefore, that absorption of the triterpene acid from the digestive tract is relatively low and continuous resulting in cholestasis.

The liver injury of lantana poisoning is specific to the hepatocytes and results in inhibition of canalicular bile secretion. The injury to the bile canalicular membrane has been observed early in the development of cholestasis as morphological change in the membrane and loss of membrane enzyme activity (Pass, 1986). The morphological changes include loss of canaliculi microvilli and then collapse of the canaliculi and these changes contribute to the decrease in bile secretion seen during lantana poisoning. It has been suggested that injury to the bile canalicular membrane may result from an interaction of triterpene metabolite with some components of the membranes, and that canaliculi injury may be the initial effect of cholestasis.

The toxins exert their effects on the hepatocytes, and the canaliculi appear to be a major site of injury. Within a few hours after ingestion of the plant, there is a decrease in canalicular ATPase activity and collapse of canaliculi. Although the secretory function of the hepatocytes is lost, their ability to metabolize compounds is retained; to some extent, they are able to conjugate bilirubin. Toxicity is associated with an increase in the agranular endoplasmic reticulum in hepatocytes, but the significance of this change is not clear. It maybe related to alteration in amount of drug metabolizing enzymes or retention of bile constituents. Experiments have confirmed that lantana causes gallbladder paralysis but not intestinal paralysis (Pass *et al.*, 1987). The liver lesion is potentially reversible and recovery from cholestasis occurs when the absorption of toxins decreases to a rate which doses not maintain cholestasis.

### *2.3.4. Other changes associated with lantana poisoning*

Jaundice and photosensitization occur as consequences of cholestasis. Jaundice is due to accumulation of bilirubin as a result of failure of bilary secretion rather than failure to metabolize bilirubin (Pass, 1986). Photosensitization is due to the accumulation of phylloerythrin, which sensitize the skin to light. Phylloerythrin is a metabolite of chlorophyll, which normally undergoes intrahepatic circulation. During cholestasis, it is not secreted in to the bile and accumulates in the body. It has been experimentally shown that lantana poisoned sheep become dehydrated and develop a decrease serum potassium concentration and metabolic acidosis. Renal failure associated with renal tubular injury has been reported in lantana poisoned animal (Pass, 1986). Five clinically advanced bullocks succumbed within 1-10 days of observation. The total plasma bilirubin content in fatal cases was of the order of 5-50 times the normal value (Sherman *et al.*, 1981).

The osmotic fragility of erythrocytes was measured by the rate of hemolysis in decreasing concentrations of saline. The erythrocytes of normal animals resisted hemolysis until the saline concentration was lowered to 0.60%, and it was complete at the low saline concentration of 0.30%. In lantana-poisoned animals, hemolysis started even in 0.72% saline and was complete at a saline concentration of 0.44%. The hemolysis curves of animals that died were greater from the normal, but those of the calves that recovered and the one that died but had the lowest bilirubin content closely approached the normal curve (Sherman *et al.*, 1981).

Heamatological finding recorded in Red Kangaroo were leucocytosis, anemia, bilirubinemia, bilirubinuria, hyperproteinemia, and elevated alanine aminotransferase, gamma glutamyl transpeptidase and alkaline phosphatase. (Johnson and Jensen, 1998).

Lantana in goat produced an increase in the serum activities of alanine aminotransferase, aspartate aminotransferase, and alkaline phosphatase. Furthermore, these plants caused increased total blood protein levels and decreased haemoglobin concentration (Abatan *et al.*, 1996).

## 2.4. Diagnosis of lantana poisoning

### *2.4.1. Clinical symptoms*

Symptoms of lantana poisoning depend on the amount and type of lantana consumed, and under some circumstances, the intensity of light to which the animals are exposed. Early symptoms include depression, loss of appetite, constipation, and frequent urination. After a day or two the eyes and the skin of the nose and mouth start to become yellowish with jaundice and the muzzle becomes dry and warm. The eyes may become inflamed and have a slight discharge. The animal also becomes increasingly sensitive to light. Finally, the muzzle becomes inflamed (pink nose), moist and very painful, (AVIS, 2003; Shiferaw, 2001).

The clinical disease often takes acute and chronic forms. The acute form usually occurs within 24 hours after the plants are eaten. Animals exhibit gastroenteritis with bloody, watery feces, severe weakness and paralysis of the limbs followed by death in 3 to 4 days. The clinical features of the intoxication caused by the three compounds are identical and indistinguishable from those already described following dosing or feeding the toxic plant. Anorexia occurs within 24 hours of dosing and jaundice will develop within 4 days and photosensitization will develop when placed in sunlight for a day at this stage. The major clinical findings in lantana poisoning were constipation, anorexia, jaundice, photosensitization, progressive weakness, dehydration and subnormal temperature at the terminal stage (Ali *et al.,* 1995; Johone *et al.,* 2002; Shiferaw, 2001). Recumbent cattle twist their head laterally towards the flank and arc their back at stand. Necrotic lesion on the gum, lips and, ventral and lateral surface of the tip of tongue are common (Shiferaw, 2001).

The chronic form is characterized by jaundiced mucous membranes, photosensitization, and ulcerations of the mucous membranes of the nose and oral cavity. Photosensitization is a clinical manifestation that appears following cholestasis and has been recognized in cattle, sheep, and occasionally, horse for many decades. Manifestations, which appear several hours after exposure to sunlight, include burning or itching, erythema and pronounced inflammatory edema. Often the inflammation is so severe that the affected area of skin becomes necrotic and slough off leaving a raw moist surface. These changes are strictly confined to areas of the skin unprotected by pigmentation (Fig 5). In cattle and goat areas covered by thin hair and usually non-pigmented teats, udder, perineum is most often affected (Sharma *et al.,* 1981). The skin may peel, leaving raw areas that are vulnerable to fly strikes and bacterial infection. Severe keratitis may result in temporary or permanent blindness (Shiferaw, 2001).

Fig. 4 Inflamed and sloughed muzzle and nostril (Pink nose), (Shiferaw, 2001).

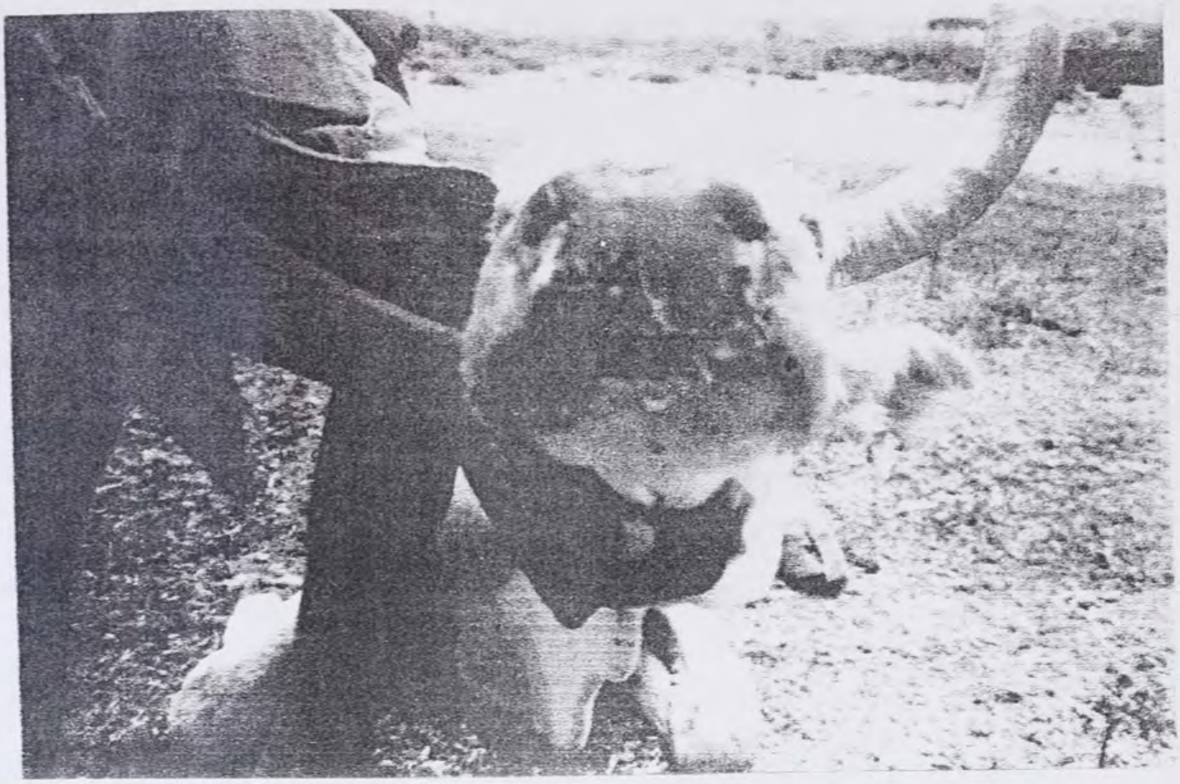


Fig. 5 Photosensitization of skin. Note that lesions are in white skin only (Shiferaw, 2001).

All affected animals avoid direct sun light and seek for shade. The mouth and nostril of some cattle have bad smell and feces are firm and dry containing mucus indicating severe constipation. Most cattle that develop a characteristic lesion die during the first five days of sickness (Shiferaw, 2001).

Shiferaw (2001) described that early symptoms in some cattle include restlessness and edema on the head, dewlap and brisket that oozes yellowish fluid. The skin also becomes dry and hard. On subsequent days, large necrotic lesions are detected on the muzzle, nostrils, tongue, teat, vulva, and scrotum of most convalescent cattle. The necrotic tissue sloughes off from muzzle, skin and teat; the skin becomes dry in some cattle and later on, photosensitization becomes prominent in few chronic cases. Some poisoned pregnant cows abort and such cows would hardly recover. Newborn calves are unable to rise and hence herder used to slaughter these calves.

### *2.4.2. Gross pathology*

The pathology in acute lantana poisoning in cattle and small ruminant is similar except the absence of photosensitization in sheep and goats that may be attributed to relatively mild liver damage, or the rapid course of toxicosis (Iea and Tutt, 1998).

Photosensitization lesions are slight or absent in sheep unless kept in bright sunlight. Yellowish discoloration of carcass is a common finding; liver is typically swollen, the bladder is distended two to three times the normal size; the kidneys and adrenal glands are swollen with the cortex pale yellowish and moist. There are accumulations of hard black and dry digesta in the colon and the rectum contains small and irregularly formed fecal pellets and copious amount of glary yellowish mucus (Pass, 1986). The rumen contains poorly digested ingesta and thus animals with lantana toxicity additionally show anorexia and are emaciated. Grossly, *Lantana camara* produces pale, swollen, friable liver and ecchymotic haemorrhages in the kidneys (Abatan *et al.*, 1996). Postmortem examination of the adult male red kangaroo revealed jaundice, the liver was swollen, mottled, and pale yellow to reddish yellow. The gall bladder was markedly distended (Johnson and Jensen, 1998).

### *2.4.3. Microscopic lesions*

The lesions produced by each of the three compounds are similar, varying only in degree. In the liver of recovering sheep, there is swelling with paleness of staining of the cytoplasm with thickening of the cell borders. Small intracytoplasmic brownish yellow bile globules are also found. Occasionally, kupffer cells contain large round or oval brownish yellow bile deposit. In the liver of fatally intoxicated sheep, hepatocytes are swollen and pleomorphic with much apparent disorganization of parenchyma architecture (Pass *et al.,* 1978). There is extensive feathery degeneration and vacuolation of parenchymal cells of the preportal zone. Many hepatocyte nuclei are enlarged. The kidneys are similarly affected in all affected animals and the change included extensive dilation of the lumen of most uriniferous tubules. In some nephrones, there was extensive foamy swelling of cytoplasm of the cells of the proximal convoluted tubules (Pass, 1986).

In summary no single feature is adequate for the diagnosis of lantana poisoning. This suggests that differential diagnostic procedures including simultaneous onset of illness of similar severity in several animals, sudden death with photosensitization in conjunction with other clinical, postmortem and histopathological findings as well as , liver function test and history of exposure have utmost importance in providing a clue. The first outbreak reported from Eastern Ethiopia was diagnosed by strong evidence generated from clinical, epidemiological survey, gross postmortem findings changes and interviews during the course of the disease (Shiferaw, 2001).

## 2.5. Treatment and control

The development and maintenance of cholestasis in lantana poisoning is the result of continuous absorption of toxin from the rumen and removal of this toxic material will lead to recovery from the disease. It has been shown that intoxicated sheep recover when the toxic rumen content is manually removed (McSweency and Pass, 1983). This can be achieved by ruminotomy.

Administration of adsorbent materials such as activated charcoal to bind the toxin in the rumen will prevent further absorption. Lantana poisoned cattle can be successfully treated by giving 2.5 kg of activated charcoal in 20 liter of multiple electrolyte solution by stomach tube;

sheep is similarly treated by giving 500g charcoal in four liters of fluid (Pass and Stewart, 1986). Activated charcoal at a dose of 5g/kg body weight orally produces good protection. Bentonite is considered to have promise as a cheap alternative to activated charcoal for therapy of lantana poisoning of cattle. However, calves given bentonite took 3 days longer on average to recover fully than those given activated charcoal but the effects of the 2 therapies on plasma total bilirubin concentrations were statistically indistinguishable (Mckenzie, 1991).

Treatment for photosensitive dermatitis may include keeping the animal under shade, local application of antihistamine to damaged area of skin and administration of antibiotics to avoid secondary complications. An improvement in the condition of animal is usually seen within 2 to 3 days after treatment (Mclennen and Amos, 1989). The antidotes which significantly reduce photodermatitis include orally given liquid paraffin, oils of sesame, safflower and castor, activated charcoal and magnesium sulphate, promethazine and dexamethasone. Activated charcoal-magnesium sulphate combination or promethazine significantly reversed impairment of excretory liver functions (Bhide and Akhter, 1991).

The toxic triterpene acid lantadene A and lantadene B that are extracts of *Lantana camara* were conjugated to bovine serum albumin. The conjugates were emulsified with adjuvant and injected into sheep and cattle. Vaccinated animals produce antibody against the toxic compound. Cholestasis was less severe in vaccinated than in non-vaccinated sheep(Stewart et al., 1988)

# 3. MATERIALS AND METHODS

## 3.1 Clinical prevalence study

### *3.1.1. Study site*

The study was conducted in Harari Regional State and Babile districts of East Hararghe Zone of Oromia Regional State. The area is located between $42^0$ 53' 20'' East and $09^0$ 16' 40'' North of equator, bounded by four districts of East Hararghe Zone and one district of Somali Regional State in the east. The altitude of the area ranges from 1200m above sea level at Erer river basin to 2300m above sea level at Harar chain mountain. Mean annual rainfall of 800 milliliter and temperature ranges from 20 –27 $^0$c.


**Fig 6 Study area of Eastern Hararghe zone (HBCO, 2000).**

### *3.1.2. Study population*

From the total livestock population in the area cattle rank first that approximate 58 percent goats 33 percent and sheep 9 percent as shown on the Table 4. The type of goat management systems practiced in the study area was small flock kept in mixed farming systems with flock size that range from 1 to 12 with an average of 5 per household.

### *3.1.3 Sampling technique and Study design*

The study area was initially categorized into different segments based on the putative risk factors that affect the occurrence of the disease. As a result, two Geographic areas were identified from the two districts. The two geographic areas are localities around Erer River basin and other plateau and chain mountain. Twenty percent of the villages (33 from Harari and 53 from Babile) were selected randomly from the area for the first stage sampling. From each village 15 goats were selected randomly for the clinical survey making a total of 1290 goats for this study. The sample size was determined by considering 50 % toxicity rate to get maximum sample size (Thrusfield, 1995) as estimates are generally lucking.

**Table 4. Livestock population of study area (HBCO, 2000).**

| No | Species | Harari | Babile | Total | Percentage |
|---|---|---|---|---|---|
| 1 | Cattle | 34008 | 39524 | 73532 | 58 |
| 2 | Sheep | 5774 | 5719 | 11493 | 9 |
| 3 | Goats | 19098 | 22752 | 41850 | 33 |
| | **Total** | **58880** | **67995** | **126875** | |

### *3.1.5. Study methodology*

The clinical survey involved one visit to a sampling site at which 15 goats had been randomly selected from villages were inspected for clinical evidence of lantana poisoning and questionnaires were administered to 251 flock owners. A clinical diagnosis of lantana poisoning was based on simultaneous onset of illness of similar severity in a flock, presence of jaundice, rumen stasis, photosensitization, dehydration, history of feed shortage and browsing in lantana infested area. In additional confirmatory diagnosis was made possible by postmortem inspection of terminally ill goats (n=6) and carcass (2) obtained from poisoned flocks in different villages. Finally, specimens were collected and processed for histopathology examination.

In nut shell, information gathered through interviewing flock owners, inspecting the animal for clinical signs and gross postmortem and microscopic lesions, extensive distribution & availability of the toxic plant, and goat management that favor lantana toxicity were simultaneously analyzed to arrive at a final diagnosis in a clinical prevalence survey.

#### *3.1.6. Questionnaire survey*

As part of a cross-sectional study of lantana poisoning, 251 livestock owners were interviewed. A pre-tested questionnaire was administered on a single visit to collect data from livestock owners. The interviewees responded to questions about livestock health problems, knowledge of lantana poisoning, uses of the plant and its harmful effect in the area. The questionnaire was additionally used to quantify and highlight the extent of infestation by comparing with other vegetation in communal grazing area. Furthermore, photographic and video evidence were gathered. This helped to determine the seasonal pattern of disease in different area.

### 3.2. Controlled experimental trial

#### *3.2.1. Sample plant collection*

The test plant was lantana with a yellow center pink colored flower most abundant in the study area. The plant was identified by Harari Region Plant Laboratory, based on morphological characteristics (Fig 7). The plant leaves were collected and allowed to dry at room temperature for 5 days. The test powder was obtained by grinding the dried leaves with local wooden grinder *"Moyea" or " Mukecha"* and filtered through approximately 1 $mm^2$ wire-mesh sieve.

### *3.2.2 Experimental design*

Twelve sheep and 20 goats, matched both for age and sex were purchased from a local market in the study area where the animals got frequent access to lantana and clinical disease have been reported. All animals were physically examined at the spot for evidence of diseases. Further laboratory examination was made to elucidate parasitic infestation with due emphasis to liver flukes using standard coprological technique (Hendrix, 1998). All animals were treated with Albendazole at a dose rate of 15 mg/kg body weight, sprayed with acaricide (Diazenon) twice, and vaccinated against pasturellosis during the 22 days-long acclimatization period. A packed cell volume (PCV) was determined from jugular blood sample by centrifuging at 3000 rpm for 5 minute.

Seven sheep and ten goats were randomly assigned to receive toxic materials using stomach tube, at the maximum dose of 40g/kg body weight (Briton and Tokarina, 1995). While five sheep and 10 goats were left as a control group. The treatment and the control group were kept together and observed for the clinical sign to manifest for 30 days.

After treatment the animals were examined twice a day for any derangement and any clinical signs shown were record. PCV and body weight were taken at the start, in the middle and at the end of experimental period. Recumbent animals were necropsied and detail lesions in different organs were recorded.

### *3.2.3. Laboratory methods*

Samples of different organ and tissue from both treated and control animal were fixed in 5% buffered formaldehyde and routine histopathology was performed on HE stained paraffin sections to determine microscopic abnormalities (Jubo *et al.*, 1991). Microscopic examination was done on 5-6 micro millimeter HE stained tissue section at 40X magnification.

### *3.2.4. Response variables*

The response variables in the study were none poisoned when no clinical symptom developed with in 25 days of treatment, poisoned and recovered when clinical symptom develops but animal recovered and poisoned and dead when clinical symptom develop and the animal is recumbent. The main criterion for recovery from intoxication was improvement in demeanor, appetite, and rumen motility.



### 3.3. Data collection, analysis and management

Data were collected taking into account the area of study and season during which the survey was conducted. Age categorization was made using dental eruption and wear as previously been described. Chi-square statistical analysis and comparisons of proportion were used to analyse the data as appropriate. In all the analysis; the confidence level was held at 95% and P±0.05 was set for significance.

## 4. RESULT

### 4.1. Result of clinical prevalence

From the Table 5 one can see the intoxication rate is significantly higer ($P<0.05$) in Harari Region compared to Babile district. Similarly intoxication rate in Erer valley was significantly higher ($P<0.05$) compared to other geographic area (Table 6). Age also seems to have significant effect on a naturally occurring lantana poisoning (table7) But sex of the animals did not have significant contribution to lantana poisoning in the study area.

**Table 5 Area based prevalence of lantana poisoning in goats.**

| District | Total | Positive | Clinical prevalence | $X^2$ | P-Value |
|---|---|---|---|---|---|
| Babile | 795 | 69 | 8.769 | | |
| Harar | 495 | 146 | 29.49 | 95.16 | .000 |
| **Total** | **1290** | **215** | 16.67 | | |

Table 6. Clinical prevalence between two geographic areas

| Geographic area | Total | Positive | Clinical prevalence | $X^2$ | P-value |
|---|---|---|---|---|---|
| Erer valley | 510 | 203 | 39.960 | 327.39 | .000 |
| Other parts | 780 | 12 | 1.535 | | |
| **Total** | **1290** | 215 | 16.67 | | |

**Table 7. Sex dependent prevalence study of lantana poisoning.**

| Sex | Total | Positive | Clinical prevalence | $X^2$ | p-value |
|---|---|---|---|---|---|
| Female | 1014 | 176 | 13.64 | 1.62 | .202 |
| Male | 276 | 39 | 14.13 | | |
| **Total** | **1290** | **215** | **16.67** | | |

Table 8. Age prevalence of lantana toxicities

| Age | Total | Positive | Clinical prevalence | X2 | P-value |
|---|---|---|---|---|---|
| Milk teeth | 460 | 47 | 11.380 | 25.7 | .000 |
| 1 pair* teeth | 321 | 62 | 19.315 | | |
| 2 pair* teeth | 261 | 46 | 17.624 | | |
| 3 pair* teeth | 190 | 46 | 24.215 | | |
| 4 pair* teeth | 58 | 14 | 24.138 | | |
| Total | 1290 | 215 | | | |

permanent incisor

Fig.7 Yellow center pinc *Lantana camara* a test plant for thetrial.

Lantana species available in the area includes red, yellow, white, pink, yellow center pink, yellow centered red, purple colored flower and a combination of these colors are found widely in the study area. The exception is red color type dominated in GO & NGO's gardens.

**Fig 11. Number of respondents regarding animals feedining lantana**

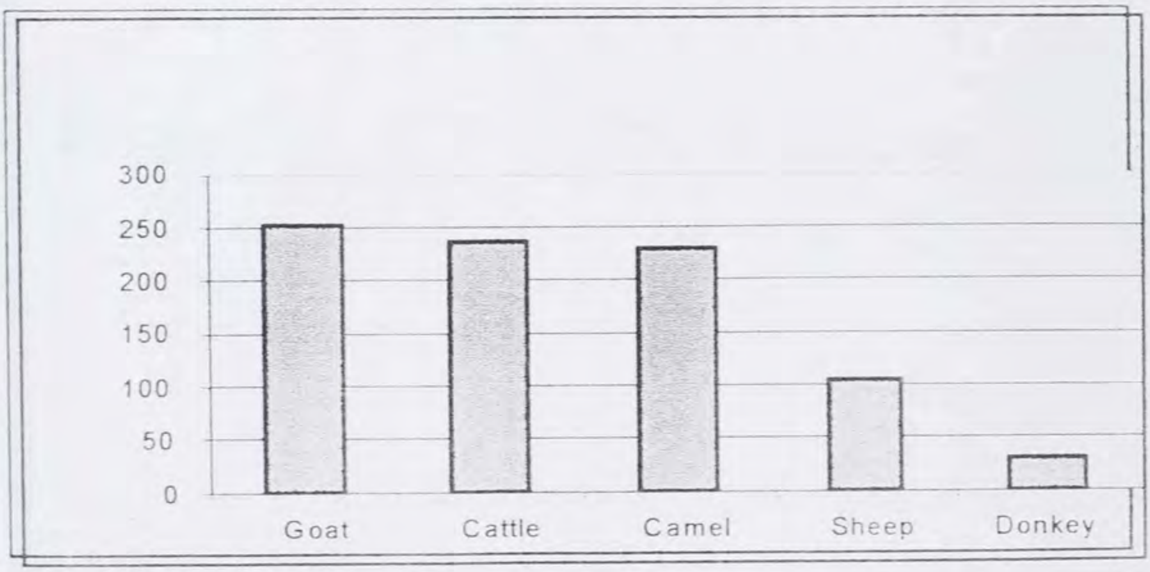
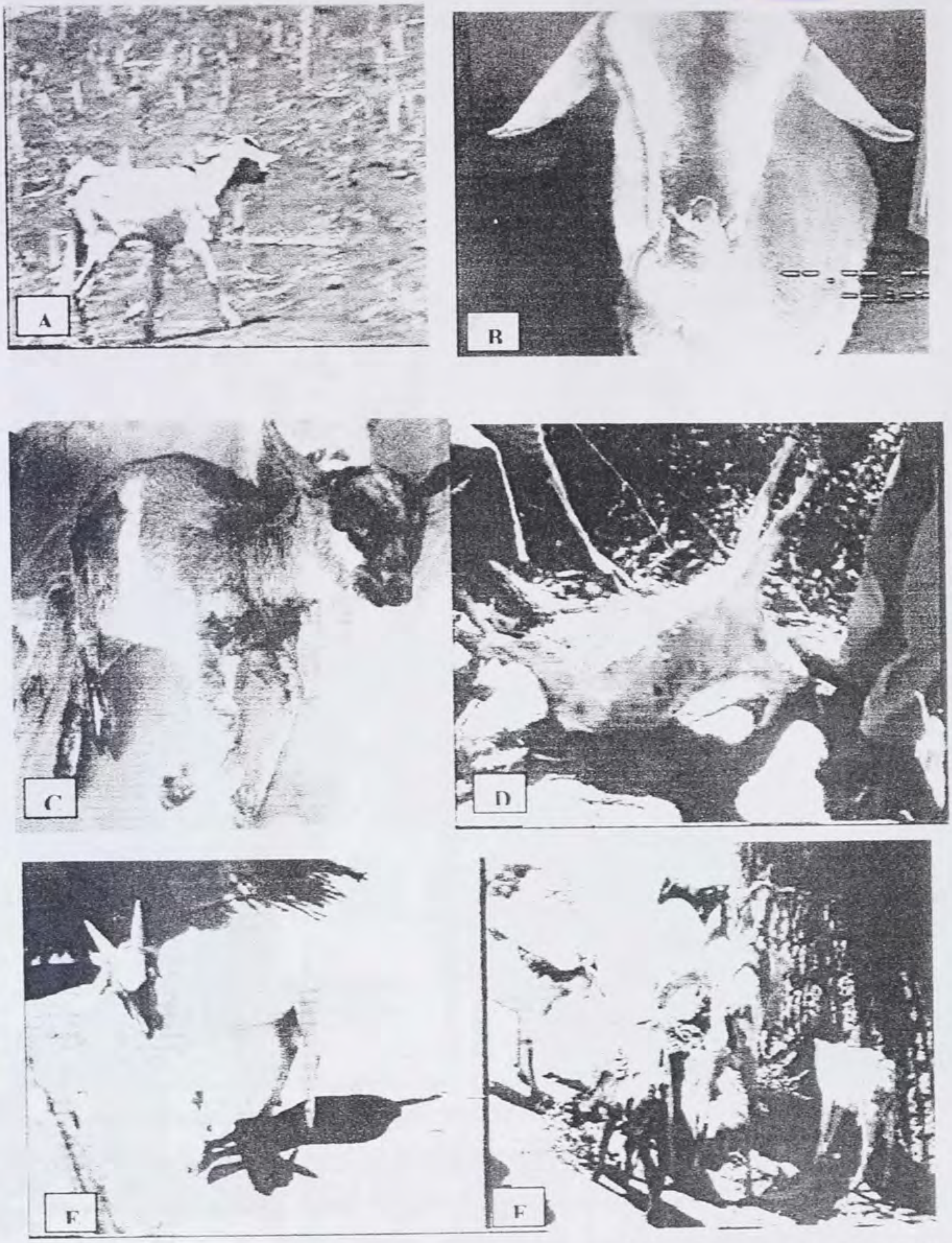
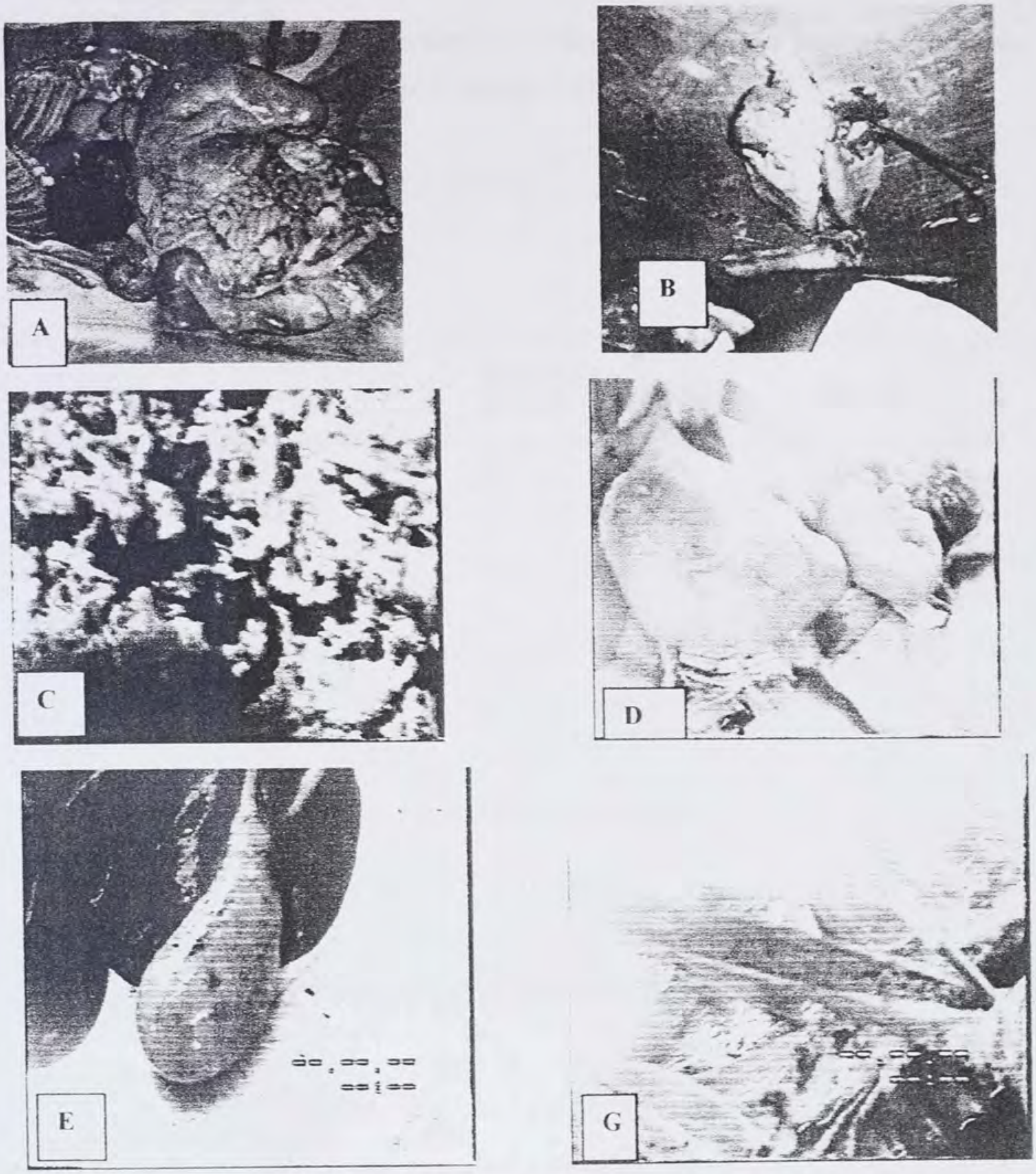


**Fig. 8 Distribution of plant in Erer River basin**


**Fig. 9 Clinical appearance of naturally poisoned goats**



**A** *Emaciated and dehydrated kid with dry and firm rumen* **B** *Lantana poisoned goat complicated with bacteria pneumonia* **C** *Poisoned flock that had five sick goats***D** *Terminally illt poisoned kid* **E** *Acutely poisoned male goat with ruminal atony* *F Lantana poisoned flock that had lost four pregnant goats where two of them were autopsied.*




**A** Accumulation of hard black and dry digesta in the colon and rectum contains small with irregularly formed fecal pellets. **B** lung from autopsied goats was complicated with pasturellosis. cranial lob of the lung is congested. **C** One can easily see bulk of rumen completely filled with lantana leaves and seeds **D** Autopsied natural poisoned goat was pregnant female. **F** swollen liver and distended gallbladder two to three times normal size with full of deep yellow color bile. **G** Rresult from static rumen one can find ingesta inside esophagus

### 4.2. Questionnaire result

Interview was made with livestock owners in the study area to evaluate socioeconomic status, distribution, toxicity and other impacts of lantana (Table 9-16).

**Table 9. Socioeconomic importance of lantana.**

| Uses of lantana | Respondents (n=251) | Percent |
|---|---|---|
| Traditional treatment | 60 | 23.9 |
| Source of firewood | 231 | 92.03 |
| Cut and sale for fuel | 84 | 33.47 |
| use for fencing | 191 | 76.10 |
| Cleaning milk and water cans | 144 | 57.37 |
| Improve soil fertility | 15 | 5.98 |

**Table 10 Livestock species affected from farmers prospective**

| Affected | Freq. | Percent |
|---|---|---|
| Cattle | 16 | 6.37 |
| Goat | 39 | 15.54 |
| Do not know | 196 | 78.09 |
| **Total** | **251** | **100.00** |

Table.11 Response to seasonal forage availability

| Forage status | Wet season forage | | Dry season forage | |
|---|---|---|---|---|
| | Freq. | Percent | Freq. | Percent |
| Enough for your animal | 137 | 54.58 | 3 | 1.20 |
| Marginal | 108 | 43.03 | 41 | 16.33 |
| Very little | 6 | 2.39 | 207 | 82.47 |
| **Total** | **251** | **100.00** | **251** | **100.00** |

Table 13. Respondents' observation on disease encountered months

| Month | Number of respondents | Percent |
|---|---|---|
| December | 16 | 6.37 |
| February | 10 | 3.98 |
| January | 11 | 4.38 |
| June | 7 | 2.79 |
| May | 4 | 1.59 |
| November | 5 | 1.99 |
| Not encountered | 198 | 78.88 |
| **Total** | **251** | **100.00** |

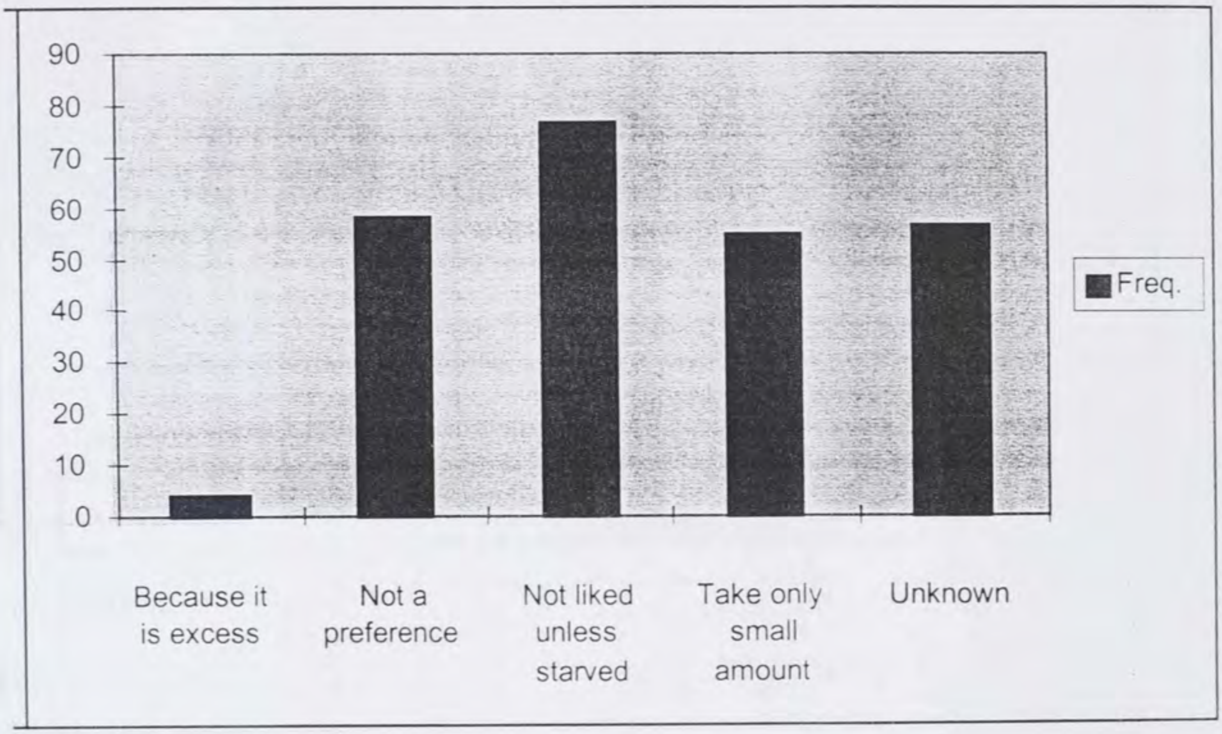
Table 14 Harmful effect of lantana from farmer's perspective.

| No | Descriptive | Number of respondents | Percent |
|---|---|---|---|
| 1 | Not harmful | 131 | 52.19 |
| 2 | Dominating or replacing other vegetate | 98 | 38.25 |
| 4 | Kill, clear, destroy or eliminate the rest | 20 | 7.97 |
| 5 | Lower soil fertility | 2 | 0.80 |

**Table 12. Distribution of lantana comparing with other vegetation**

| Other plants | Number of respondents | Percent |
|---|---|---|
| Lantana is less distributed than others | 69 | 27.49 |
| Lantana looks equally distributed with others | 124 | 49.40 |
| Lantana is widely distributed than others | 58 | 23.11 |
| **Total** | **251** | **100.00** |

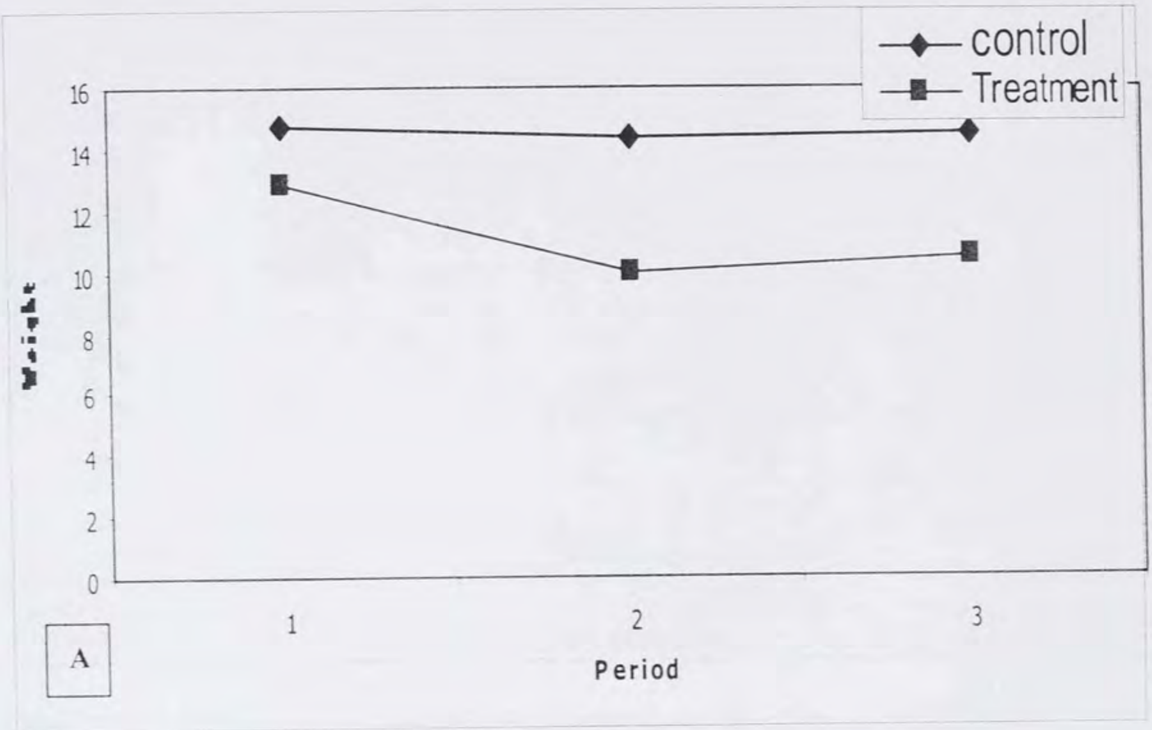
**Fig 12 Response why farmers do not cut and feed lantana to animals**




### 4.3 Result of experimental trial

From 10 goats and 7 sheep that were experimentally intoxicated and have developed the clinical symptom of lantana poisoning. This includes; phototoxic dermatitis, jaundice, ruminal stasis, dehydration (Fig 16). Three of intoxicated goats and three of intoxicated sheep died during the 30 days experimental period giving 30% and 42% mortality rate respectively. In the two study species, fifteen control animals (10 goats and 5 sheep) were normal until the end of study. During postmortem examination of animals invariably presented jaundice carcass, swollen liver with distended gallbladder and accumulation of hard dry ingest a in the colon and part of small intestine compared to control group (Fig 16 and 17). PCV and body weight were taken at the start, in the middle and at the end to study changes associated with lantana poisoning. The result has indicated that a gradual increment in PCV and decrement in weight was found in drenched sheep and goats while there were no change in control group (fig 13 &14 ).

**Fig. 13-Weight measurement of treated and control sheep (A) and treated goats (B)**



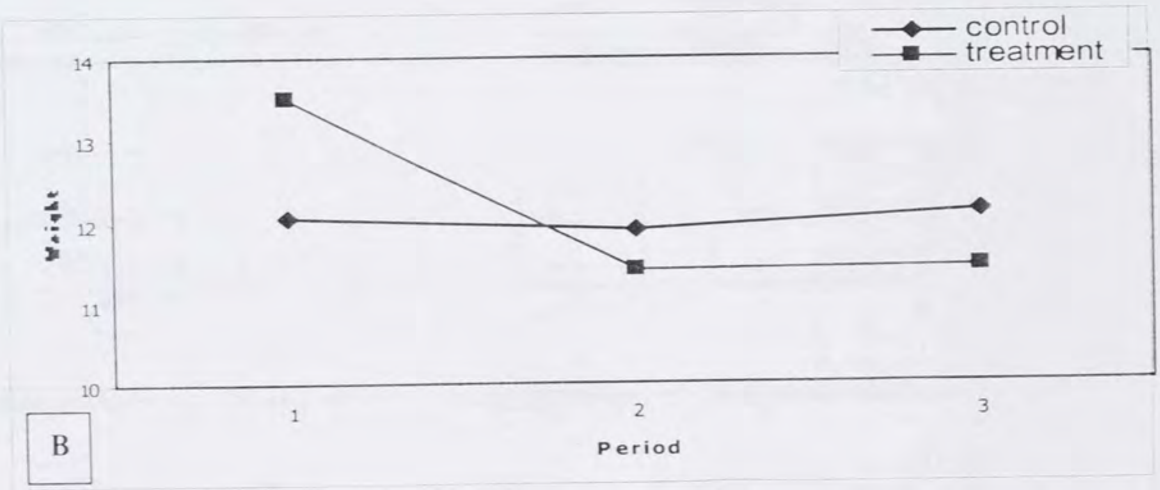



**Table 15 Morbidity and Mortality of experimental animals.**

| Species | Number of treated animals | Number of sick | Dead | Morbidity | Mortality |
|---|---|---|---|---|---|
| Sheep | 7 | 7 | 3 | 100% | 42% |
| Goat | 10 | 3 | 3 | 100% | 30% |

**Fig 14 PCV measurement of treated verses control sheep**

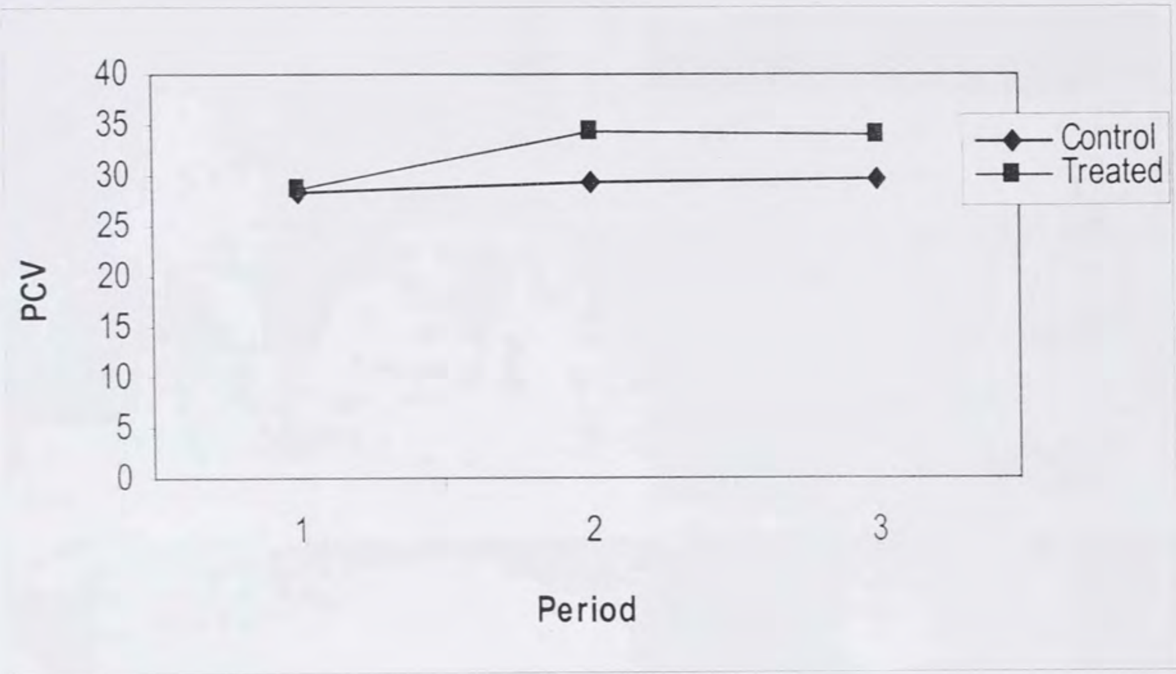
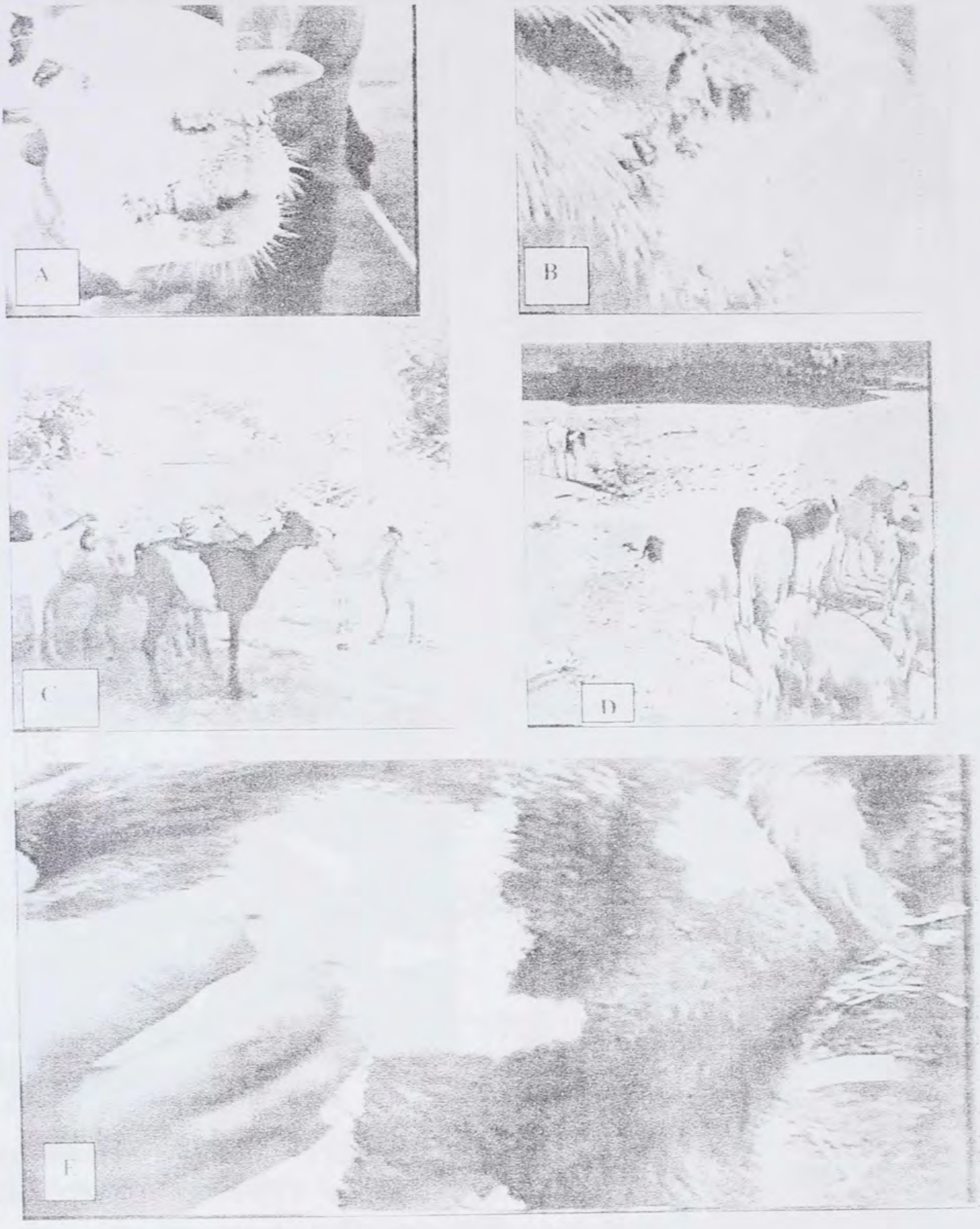



**Table 16. Frequency of clinical symptoms and mean duration time in days.**

| | Description symptoms | Number of sheep | Number of goats | Mean days | | Range days | |
|---|---|---|---|---|---|---|---|
| | | | | Sheep | Goat | Sheep | Goat |
| 1 | Jaundice | 7 | 10 | 11.7 | 12.8 | 7-17 | 7-21 |
| 2 | Firm and dry rumen | 7 | 9 | 11.6 | 10.5 | 8-21 | 7-22 |
| 3 | Diarrhea | 0 | 6 | 0 | 4.8 | 0 | 2-8 |
| 4 | Photosensitization | 7 | 2 | 15 | 10 | 7-21 | 8-12 |

Sheep (n=7)
Goats (n=10)

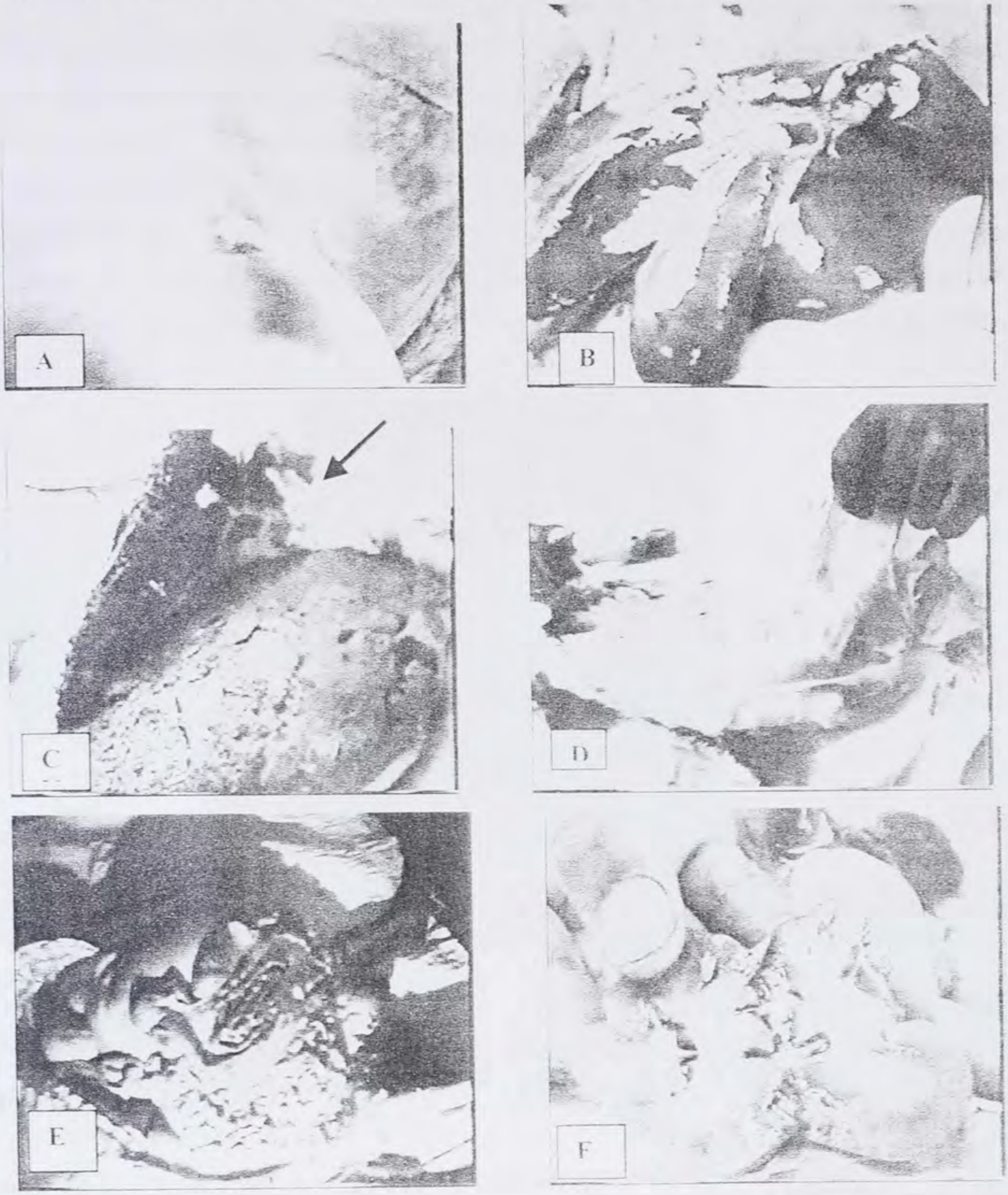
Fig.16 The clinical symptoms of experimentally intoxicated sheep and goats




*A. Sheep developed phototoxic [illegible] lesion on the lips and [illegible] B. A goat develop phototoxic dermatitis around the [illegible] C. Intoxicated [illegible] not tolerate [illegible] and moved to shade [illegible] D. intoxicated sheep that [illegible] incoordination [illegible] E. Firm and [illegible] palpations*

## Gross pathology

**Fig. 17 Post mortem lesions in experimentally poisoned sheep and goats**




A *Yellowish discoloration of carcass.* B *liver is typically swollen, the gal bladder is distended three to four times normal size* C *Rumen attached with content result ruminal ulcer* D *A goat carcass after 11 days following intoxication and sever diarrhea.* E *A accumulation of hard and dry ingesta in the colon and the rectum contains irregularly formed fecal pellets that extend up to small intestine* F *kidneys are swollen with the cortex yellowish and moist in severely poisoned sheep.*

Microscopic lesions

The lesions produced by natural and artificially induced poisoning are similar, varying only in degree. In the liver of some goats there is swelling with paleness of staining of the cytoplasm with thickening of the cell borders. In the liver of intoxicated sheep, hepatocytes are swollen and pleomorphic with much apparent disorganization of parenchyma architecture.. Many hepatocyt nuclei are enlarged and bile duct proliferation. The kidneys are similarly affected in all animals and the change included extensive dilation of the lumen of most uriniferous tubules. In some nephrones, there was extensive foamy swelling of cytoplasm of the cells of the proximal convoluted tubules. This finding quite agrees with different studies by (Pass, 1986; Seawright. and Hrdlicka, 1977; Pass *et al.*, 1987).

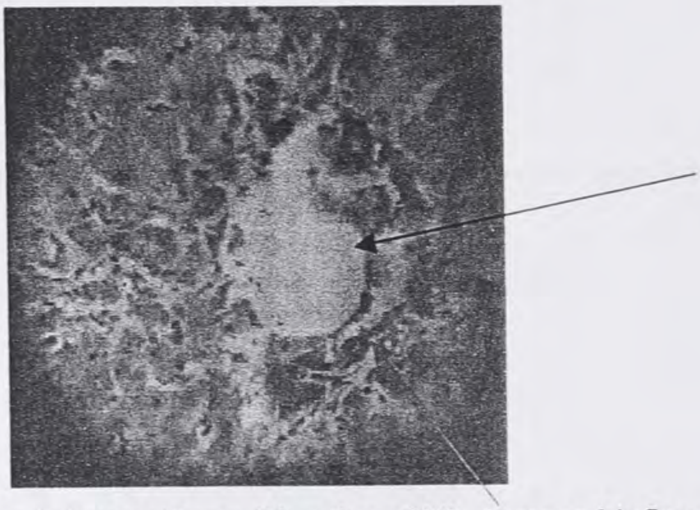


**Fig.18 Liver of intoxicated sheep with proliferation of bile ducts and inflammatory cell infiltration (magnification:10X)**

**Fig.19 Liver of intoxicated sheep, vaculated hepatocytes.(Magnification: 40x)**

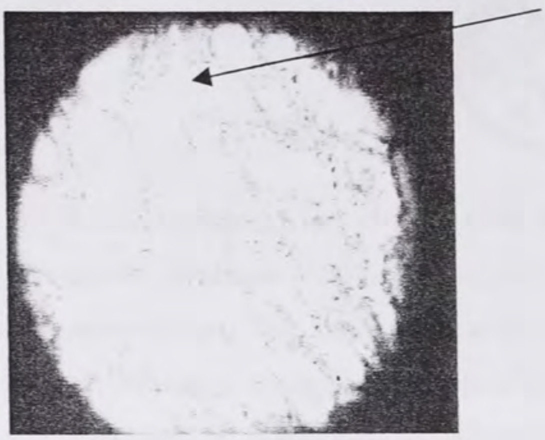


**Fig.20 Fatally intoxicated goat with heavily dilated proximal convoluted tubules. (Magnification 10x).**

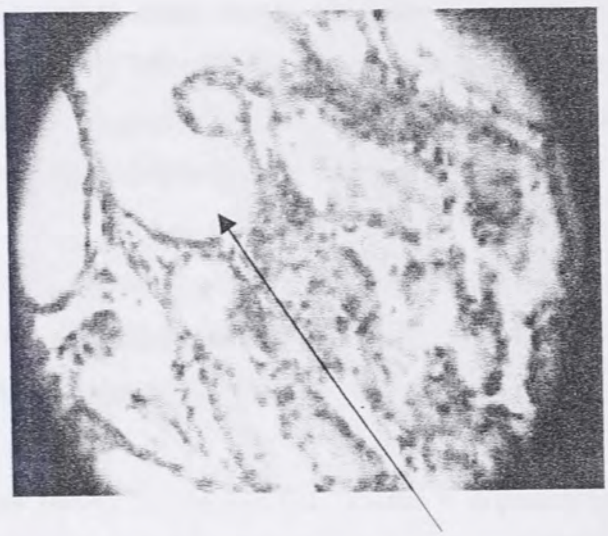


**Fig.20 Kidney intoxicated goat with heavily dilated proximal convoluted tubules. (Magnification 40x).**

## 5. DISCUSSION



The prevalence rate of 16.7% reported in the study is quite high to call for some kind of mitigating measures. Previously, Shiferaw (2001), has reported similarly higher toxicity rate in cattle from the same environment .The study has indicated that all important livestock species in the area might be invariably susceptible to lantana toxicity when exposed to higher dose. Animals are usually exposed to higher dose of lantana during dry season when other palatable pasture is scarce.

The clinical prevalence rate differed significantly between the two study sites (Table 5) and two geographic location (Table 6). During the dry month, livestock including goats are taken every other day to Erer River basin for watering. As a result, animals were exposed to excessive dose of lantana because the plant is relatively abundant around the river basin. A significantly higher prevalence rate in Harari Region compared to Babile district is due to higher distribution of plant and because route of introduction was town (Shiferaw , 2001).

Similarly, age dependent study reveal significantly higher prevalence rate in older goats compared to young ones (Table 8). Since more than 50 % of the goat population is composed of breeding females. Pregnancy and lactation related stress factors might make this segment of population more vulnerable to lantana toxicosis.

Sex dependent study (Table 7) on the other hand reveal no statistically significant difference ($X^2$, P value). This might indicate that once exposed to high level of lantana both sexes are equally susceptible (Shiferaw, 2001).

The questionnaire survey has proved that lantana is important plant in the study area. About half (49.4%) of the respondents indicated that lantana is equally distributed with other vegetation in the uncultivated bush and shrubs lands used for communal grazing (Table 12) constituting about 102,500 hectare (BRDAB, 2004). On the other hand, it is reported to be widely distributed, dominating other vegetation around Erer vally (Fig 8).

Twenty four percent (n=251) of the farmers reported the uses of lantana in herbal medication The extract of chopped green leaves are drenched to serve as purgatives and combat indigestion problems. This process among other things might exacerbate toxicity problem which is mainly manifested by decreased appetite and ruminal atony. A good proportion of respondents reported other uses of lantana that include energy source for home consumption and income for selling the cut (Table 9).Lantana is also widely used widely used for fencing around the boundaries of farm, and around encampment (Table 9). It is also used for cleaning of milk cans and water thanks. Furthermore, lantana is regarded as improving soil fertility (Table 9) which agree with previous observation (Stella *et al*, 2000), that lantana can be used for mulching crops: one tones per hectare of leaves was found to double and occasionally treble crop yield. Several other respondents (Table 13) describe the harmful effect of lantana including the fact that it is invading farming area replacing other vegetation and is incriminated deteriorating soil fertility.

The clinical signs of lantana poisoning in both sheep and goats included depression, decrease appetite, static rumen, jaundice, photosensitization, dehydration and firm dry feces (Pass, 1986, McSwaay and Pass 1983). Urine out put was reduced and the urine was deep yellow color. Other sign developed by two sheep and one goat was in-coordination. These sheep were unable to walk and stretch its front and hind legs and laid dawn turning the head toward rights flank (Fig 16 D).

The clinical sign of lantana poisoning were most sever at day 7 to 14 post-treatment. At this time animals were depressed recumbent and rumen was static. They showed moderate to sever jaundice and dehydration. The course of clinical disease was quite similar in both sheep & goat. The difference was death began earlier in sheep on $9^{th}$ day after intoxication while goats started dying on day 15.

Unlike goat seven photo toxic dermatitis developed in sheep on none pigmented skin (Table 14). The lesion on the nostril and lips started since $4^{th}$ days of intoxication and become mach sever between $8^{th}$ to $14^{th}$ days. The lesion characterized by inflammation, exudation and accumulation of dead tissue on the lips and nose (Fig 16A). However, none of the goats develop this lesion. Similar lesions on muzzle were observed in cattle (Fig 4) (Shiferaw, 2001).

Two goats develop phototoxic dermatitis. One goat around perineum (Fig 16B) the other on the head between horn buds. The lesion started on $4^{th}$ day following intoxication and become sever between $8^{th}$ to $15^{th}$ days. It is characterized by inflammation and necroses followed by sloughed off living red wound that started healing process latter on. The head lesion is similar but it was mild.

Six intoxicated goats were diarrheic starting from the $3^{rd}$ day of intoxication for three days except one goat that becomes diarrheic starting from $4^{th}$ day until scarified on $11^{th}$ day. Consistency of diarrhea was watery with mucus. Four goats were not diarrheic but develop constipation with firm and dry pellets. Two of these constipated goats were recumbent & autopsied. None of the intoxicated sheep were diarrheic and had constipated.

From the $5^{th}$ day after intoxication, all sheep & goats developed firm and dry rumen on palpation which lasts for 20 days. One goat is exceptional; did not develop dry rumen because it was diarrheic until finally sacrificed for autopsy (Fig 17D). Consistence with previous observation (Shiferaw, 2001, Mandial and Rahdawa, 1998, Mcsweeney and Pass, 1983) other symptoms like weight loss icterus (jaundice), sunlight intolerance dull hair cots weakness and reduced appetite observed.

Yellowish discoloration of carcass is a common finding; liver is typically swollen, the gal bladder is distended two to three times normal size; the kidneys are swollen with the cortex yellowish and moist (Fig 17 A, B, F) Yellow fluid was observed in abdominal and thoracic cavity. The rumen content became dry with poorly digested ingest a. This finding are in agreement with quite agrees with previous reports (Seawright and Hrdlicka, 1977; Pass *et al.*, 1987).

## 6. CONCLUSION AND RECOMMENDATION

Since its introduction and distribution as an ornamental plant lantana has been spreading to infest the whole eastern highlands and was equally distributed with other vegetations in more than half of bush and shrub lands of study area. The study demonstrates lantana species abundant in study area was toxic to sheep and goat. It is a major animal health menace in both wet and dry season. A clinical prevalence in Erer valley was disquieting that needs due attention for sustainable food self sufficiency.

The impacts of lantana infestations are notable and can affect: Livestock health, reduce grazing area and impair forest industries. Not all impacts are negative; lantana serves as source of firewood, serves as traditional treatment, cleaning plastic canes, and fence around farm boundary.

But the cost of lantana infestations however, outweighs the benefits. Until the community accepts this conflict, it is unrealistic to expect a change in attitudes or commitment to lantana management and control.

Lantana management strategy should develop by consulting representative of livestock owners, policy makers, environmental protection, pest control and prevention, researchers, Non Governmental Organization and other Organization working in the area of food self sufficiency.

Minimize impact, prevent new introduction and distribution, increase community awareness in order to gain support from the community, determine level and extent of current infestations.

Lantana is generally widespread and often receives a lower priority for resources because it is not recognized as an emerging threat hence continuing to invade new areas. Its control now beyond the ability of many individual landholders, and without sustained commitment by the whole community lantana will continue to invade new habitats.

## 7. APPENDIXES



### Interview questionnaire

**General Information**

District ………………Peasant association……………village ………Date……………….

Name ………………………………….. Interview code……………………..

Age ………20s… 30s…… 40s…. 50s…… >59……

Ethnicity……………Religion ………..Formal education None…….. Read & writes

Type of holding ☐ *Crop=1 Livestock=2 both= 3* ☐ ☐

If yes for animal

*Owned spices*

☐ Cattle ☐ Sheep ☐ goat ☐ Camel ☐ Donkey

*Distance travel to grazing and watering from village (two ways)………* ☐

Which of the following score best describe your forage availability during various seasons. What are your copping mechanisms?

1. very little
2. Marginal
3. enough for your animal
4. excess of your animal

| No | Seasons | Score | Response |
|---|---|---|---|
| 1 | Rainy season | | |
| 2 | Dry season | | |

Which of the following score best describe the amount and distribution of lantana by comparing with all other vegetation in your community range land.

1. Lantana is very less distribute than others (<25).
2. Lantana is less distributed than others (25-49).
3. Lantana looks equally distributed with others (50).
4. Lantana widely distributed than others (50-74).
5. Lantana very widely distributed than others (>75).

Do you know toxic plants that cause disease to your livestock?

*Yes* ☐ *No* ☐

*If yes list different toxic plant that you avoid livestock from grazing.*

(Local names, scientific names & species affected)

1…………………………………………………………………………………

2…………………………………………………………………………………

Is lantana native to the area?

Yes ☐ No ☐

When do you think first observed (since haw many years) ……………………

Where do you think is the source ………………………

Do animals eat lantana? Yes…☐ No…..☐

If yes which animal species

Cattle ☐ Sheep ☐ Goat ☐ Camel ☐ Donkey ☐

Do you cut and feed lantana to animals?

Yes …….☐ No……☐

If not, why?

……………………………………………………………………………………

……………………………………………………………………………………..

Dose it use for traditional treatment? Yes…….☐ No……….☐

If yes for what type of disease

a………………… …………..

b………………………………

c……………………………..

Can it use as source of firewood for home consumption?

Yes…… ☐ No ……….☐

If yes, do you or seen others cut and sale as source of firewood?

Yes ☐ No ☐

If not; why not?

……………………………………………………………………………………

……………………………………………………………………………………..

Have you planted lantana for use? Yes……..☐ No….☐

If yes for what purpose ………….

Fence = 0, firewood=1, soil erosion☐feeding=3, others 4.

Mention other uses of lantana

1……………………

2…………………..

3…………………..

Do you know demerit of lantana?

Yes ☐ No ☐

*If yes list demerit of the plant*

1…………………………………………………………………………

2…………………………………………………………………………

3…………………………………………………………………………

4…………………………………………………………………………

Do you know lantana as toxic plant to livestock?

Yes ……. ☐ No…….. ☐

*If yes what is the source of your information*

*Encountered in my herd*

*Observed in other herd*

*Trained by professionals*

*Other source*

Have you observed any cases of rumen atony, Jaundice or photosensitization during the past Three years? (Explanation with picture show)

Yes ☐ No ☐

Livestock owners that mentioned YES: what were the other symptoms?

| *Constipation* | *Oral* | *Dehydration* | *Deep yellow urine* | *Photosensitization* | *Jaundice* | *Ruminal atony* | *Death* | *abortion* | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | |

Spices affected ………….. Year…………….month……………season …………..

How many were available at that time______________________________

How many were affected: ______________________________

How many died: ______________________________________

How many recovered: ______________________________________

Haw did you treat the above mentioned disease?

1………………………………………………………………………………………

2………………………………………………………………………………………

Other comments

…………………………………………………………………………………………………

…………………………………………………………………………………………………

…………………………………………………………………………………………………

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## 9. SIGNED DECLARATION SHEET

I undersigned declare that the thesis is my original work and has not been presented for a degree in any university

Name: Beshahwred Shiferaw

Signature: ____________

Date of submission: 7/25/2005

The thesis has been submitted for the examination with our approval as university advisors.

Dr Fikadu Regassa ____________

Dr Assegid Bogale ____________

Lantana Poisoning in two Administre ative areas of eastern Ethiopia

Beshahwred Shiferaw