Introduction
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Use of forage legumes in the tropics has been limited, mainly due to the lack of knowledge and inadequate economic incentives. However, advances in improving varieties and in developing suitable agronomic and management practices are promising, forage based legumes deserve consideration. Most of the tropical countries have used leguminous pulse crops for centuries as staple food to supply some or all of their protein requirements and their experience with such crops predate that of the more technically advanced countries. In countries whose religious traditions have precluded the use of animal protein the pulse crops have been widely developed, and these areas provide a background of legume culture in some depth.

The overall economic benefits of pastures and fodder crops will not only be the yield of animal products, but will largely depend on how they will supplement natural grazing lands and how effectively they maintain the soil fertility. How well these forages may be substituted for protein concentration is also important. In these circumstances, it is clear that high protein, soil enriching forage legumes, deserve a special place in future agricultural
developments. Much remains to be learnt about these tropical forage legumes. Hence, there is a need to explore and use the immense legume gene pool, which is still largely untapped.

These plants will also receive priority in the use of fertilizer, particularly nitrogen, since forage legumes fix more nitrogen than pulse legumes (Hamdi, 1982). It is also essential to improve the productivity of land suitable for cultivation and to develop complementary land use systems so as to diversify and raise the total production. The need to protect the soil between rows of plantation crops led to a technique of intercropping with trailing leguminous species which would provide a dense and quick vegetative cover both to nullify the effects of rain drop splash erosion on bare soil and to negate the erosive effect of rapidly flowing water across the soil surface. In both these practices the beneficial effect of leguminous crops upon yields of succeeding annual and companion plantation crops was early appreciated and a system of rotation with leguminous crops in an annual cropping programme developed to harvest this advantageous effect.
The use of legumes in pastures sown for the grazing animals is a recent history. The early development and use of temperate legumes took place close to the centers of origin of these plants in Europe and around the Mediterranean. This experience showed that leguminous plants are useful both as forage species and for their beneficial effect on the growth of associated grasses. The use of tropical legumes as sown species in tropical countries received little attention until about 20 to 25 years ago (Skerman, et al., 1988).

Quality in livestock products from the developing countries is now a possibility and in some cases a reality, as a result of better breeding, informed husbandry and adequate quality feeding. Improved legume based pastures appear to be the most economical approach to this latter objective.

Legumes are cosmopolitan in occurrence and they have diversified immensely in the tropics and subtropics. There are thousands of leguminous species, which are known to mankind. Of which the below listed Arachis sps., Cassia sps., Centrosema sps., Clitoria sps., Desmodium sps., Glycine sps., Lablab sps., Mimosa
sps., *Trifolium sps.*, *Trigonella sps.*, *Albizia sps.*, *Cajanus sps.* and *Gliricidia sps.* are of prime importance as pasture legumes.

The value of any feed depends on the quantity eaten and the extent to which the food consumed supplies the animal with energy, minerals and vitamins. Many tropical legumes have been studied but the results are widely dispersed in the scientific literature. Ranking the legumes in order of their nutritional value is not possible, since, very few legumes have been compared in the same environment. As the composition of legumes is influenced by the fertility of the soil in which they are grown, the age of the material, methods of handling, storage and feeding one must be cautious about comparisons.

The crude protein percentages reported for tropical legumes vary from 20 to 40 % and mean crude protein was 17.2 % for all legumes (Hutton and Bonner, 1960; Newman, 1968). Therefore the crude protein level is high in tropical legumes when compared to tropical grasses, where it varied from 7-14%. Hence, these tropical legumes act as a supplement for the low protein content in grasses.
The crude fiber of tropical forage legumes varies from 12.4% in *Leucaena leucocephala* (Farinas, 1951) to 43.4% in *Macroptilium lathyroides* (Milford, 1967) with a mean of 30.6%. This value is slightly lower when compared to that of the tropical grasses. The crude fiber content of legumes tends to increase with increasing maturity and decreasing dry matter digestibility.

The phosphorus content differs with different species owing to the stage of growth and the level of phosphorus fertilizers. The level of calcium found in tropical legumes is generally much higher than that found in the grasses. The level of phosphorus and potassium in the fertilizers influence the level of sodium. The level of magnesium in the tropical legumes studied is generally high when compared to that found in the grasses.

Mimosine (*Leucaene leucocephala*) when fed in higher concentration causes loss of hair (Oakes, 1968 and Hamilton, 1970) and enlarges thyroid glands in calves born to heifers. In fact this is used as it does not affect reproduction but gives rapid weight gains. Indospicine (*Indigofera spicata*) is an amino acid, which damages the liver of grazing animals (Hegarty and Pound, 1968). Tannins have been found in the leaves and stems of different
species of *Desmodium* (Rotar, 1965), at higher concentrations it may inhibit rumen cellulase activity.

Other toxic constituents like alkaloids, antivitamins and cyanogens are known to be present in few legumes. Although such factors do not assume any significance from nutrition point of view, however, still they also have attracted the attention of investigators while shaping legume improvement programmes.

Legumes are distributed throughout the world and are classified under the single family *Leguminosae*. This family is composed of three sub families namely -1) Caesalpinoideae, 2) Mimosoideae and 3) Papilionoideae. There are about 650 genera and more than 18,000 species in the family *Leguminosae* which makes it the third largest family among the flowering plants after *Asteraceae* and *Orchidaceae* (Polhill *et. al.*, 1981).

There are two views about the position of *Leguminosae*. Bentham and Hooker (1865), considered it as a family and included it in the order *Rosales*. Taubert (1894), Engler and Prantle (1930) followed the same system of classification. However, Bessey (1915), Jones (1955), Takhtajan (1959) and Hutchinson (1969) considered
this taxon Leguminosae as separate order Leguminales and upgraded the sub families Caesalpinoideae, Mimosoideae and Papilionoideae to the rank of families.

Hutchinson (1969), considered order Leguminales as derived from Magnoliales through Dilleniales and Rosales. Even within this order the family Caesalpinaceae is suggested to be primitive and derived from Rosaceae. Papilionaceae occupies an advanced position with Mimosaeae being intermediate in the order of sequence.

Of the three sub-families Papilionoideae is the largest and comprises of 32 tribes while Caesalpinoideae and Mimosoideae encompass five tribes each. The Papilionoideae includes several economically important grain legumes (pulses and oil seeds) many important pasture, forage crop, medicinally and horticulturally known species.

The genus Clitoria L., belonging to the subfamily Papilionoideae comprising nearly 60 species, is native to the neo-tropics, widespread in tropics and sub tropics with few species in temperate zone. Majority of the species are found in South
America, few in Central America, Mexico, African tropics and Asia particularly in India, Myanmar, China and Thailand. One-two species are reported from Australia and West Europe (Index Kewensis, 1885-1985). Species of the genus *Clitoria* are desired as ornamentals, because of their enlarged resupinate papilionaceous flowers of various colours and are also known for their medicinal and economic properties. *Clitoria* species are also used as pastures, cover crop and green manure, to check soil erosion (Whyte *et al*. 1953; Allen and Allen, 1981) and cultivated along the border as a fence. The name CLITORIA is coined from the Greek word, kleitoris, wherein, the small keel suggests the mammalian clitoris (Allen and Allen, 1981). There is no vernacular name for the genus, however, the genus *Clitoria* is commonly known as “butterfly pea” or ‘mussel shell’ climber, ‘kordofan pea’. Kelsey and Dayton (1942), adopted the name “Spurred butterfly pea” for Centrosema and “Pigeon wings” for *Clitoria*. The name “Pigeon wings” has not been accepted.

Linnaeus first established the genus *Clitoria* in the year 1753 and described four species of *Clitoria* (*C. ternatea*, *C. brassiliana*, *C. virginiana* and *C. mariana*) in “Species
Plantarum". Two species namely *C. brassiliana* and *C. virginiana* were later placed under section *Centrosema* of *Clitoria* by de Candole (1825). Bryene (1678) originally named *C. ternatea* as *Flos clitoridis ternatensibus*.

Bentham (1858), while revising the genus *Clitoria* separated *Centrosema* from *Clitoria* and classified the genus into the following three sections on the basis of habit, morphological characters of leaf and seed. Members of the section Ternatea are widely distributed in Africa and Asia confining to eastern tropical coast and Masearene Islands in Africa and to the western region of India.

Section I - *Ternatea* (6 sps)

Section II - *Neurocarpum* (12 sps)

Section III - *Clitorianthes* (9 sps)

Bentham and Hooker (1865), classified subfamily Papilionoideae and included *Clitoria* in the subtribe Glycineae of the tribe *Phaseoleae*. However, Hutchinson (1926, 1964) elevated and treated Bentham's subtribes as tribes and *Clitoria* included in tribe *Glycineae*. 
Lacky (1977), in the revisionary work on tribe *Phaseoleae* removed the genera *Centrosema*, *Periandra* and *Clitoria* from Bentham’s subtribe *Glycineae* and included them as a peripheral member of *Phaseolineae*. Later, while studying chromosome number of *Phaseoleae* he retained them in the subtribe *Clitorineaea* of Bentham on the basis of morphological characters (Lacky, 1980).

According to Bentham (1858), *C. ternatea* and *C. biflora* belongs to Ternatea section. The species name ternatea probably indicates its introduction from Ternatea, a Moluscan Island (Watt, 1989).

Fantz (1977) recognized three subgenera of the genus *Clitoria*.

Subgenus I - *Bractearia*

Subgenus II - *Neurocarpum*

Subgenus III - *Clitoria* includes one section and five species.
He regarded subgenus *Bractearia* as primitive and *Neurocarpum* as advanced on the basis of morphological characters.

Burns (1918) and Pal (1960) noted the variations in the colour and shape of the flower. The colour of the flower ranged from deep indigo blue, light purple to white, while flower shape varied from single to double in *Clitoria ternatea* L. Double flowers are conspicuous for their non-papilionaceous nature, the five petals being more or less of equal size and shape with ten free stamens. In their floral structure they resemble the pattern of the sub family Caesalpinioideae more than that of the subfamily Papilionoideae to which *Clitoria* belongs.

Fantz (1990, 1993) while working on the taxonomy of *C. ternatea* classified the species ternatea into varieties and forms mainly on the basis of flower morphology, colour of the flower, arrangements of stamens and pod size.
Flowers papilionaceous, solitary, stamens diadelphous

**Var. Ternatea**

Flowers azure to dark blue, standard yellow to white medial strip and basally purplish veins. Peduncle 1/axil, 0.5 cm long.

*f. fasciculata* Fantz.

Flowers whitish blue to purplish blue, standard white mediay and basally. Peduncle 1/axial, 1.5 cm long.

*f. ternatea* Fantz.

Flowers white, solitary, rarely 2-3 flowered with greenish to greenish white medial strip on standard and basally purplish veins. Peduncle 1/axial, 0.5 to 1.5 cm long.

*f. albiflora* (Voigt) Fantz.

Flowers “double”, actinomorphic, petals 5 standard like, stamens ten free or united in bundles.

**Var. Pleniflora**

Flowers blue. Peduncle solitary rarely paired stamens free

*f. pleniflora* Fantz.

Flowers white, solitary, rarely 2 flowered, stamens free.

*f. leucopetala* Fantz.

Flowers blue, solitary, stamens subpolyadelphous

*f. subpolyadelpha* Fantz.
In India five species of *Clitoria* have been reported (Hooker, 1879). They are grouped under two subgenus 1. *Ternatea* and 2. *Neurocarpum* (Bhaumik and Das, 1983). In the Subgenus : *Ternatea* 1. *C. ternatea* 2. *C. biflora* 3. *C. mariana* 4. *C. macrophylla* species are included whereas the Subgenus : *Neurocarpum* contains only 5. *C. cajanaefolia*.

They are primarily cosmopolitan in distribution, in the tropical and sub tropical zone from Himalayas to Ceylon, Burma and Malacca, Concan, Khasia, Singapore, Mexico, United States, and tropical America.

Of these *C. ternatea* L. is most common throughout our country and is an East African species. It often escapes and flourishes. It is widely distributed in New and Old world including Australia (Whyte *et al.*, 1953) *C. biflora* L. is restricted to Western India and is endemic. Other species are confined to Eastern Himalayan and Khasia region. *C. ternatea* exhibits polymorphism, a pretty, evergreen and perennial climber with attractive blue, whitish blue and white coloured resupinate papilionaceous flowers
has an ornamental value. Therefore, it is cultivated in gardens for flowers (Burns, 1918).

*C. ternatea* L. historically has been prized for its economic value. Every part of *C. ternatea* L. is used for medicinal purpose in India. It exhibits tolerance to drought, high pH and latterite soil. Grows well in full sunlight, needs moisture, does not tolerate water logging. Thrives well in rich soil, but grows well in ordinary well-drained garden soil (Hall, 1985).

Natives of Sri Lanka and Philippine Island consume tender green pods as vegetable (Allen and Allen, 1981; Duke and Reed, 1981). The blue corolla yields blue dye, which is used for colouring boiled rice (rice cake) in Amboyana (Rumphius, 1786; Burkill 1935; Duke and Reed, 1981). The anthocyanin pigmentation in this dye may have wider application in food technology due to its natural origin, stability and non-toxicity (Lowry and Chew, 1974).

It is a promising fodder plant as it remains green throughout the year and can withstand cutting and grazing to some extent, (Chakrabarty, 1970 and Anonymous, 1974). This species
yields maximum good quality forage (Rai and Kanodia, 1980). This plant is found to be quite palatable to animals particularly cattle and sheeps in both fresh and dry condition. It has been proved to be a successful fodder plant for growing alone or in association with other perennial grasses (Katiyar, et al., 1970; Crowder, 1974 and Osman and Diek, 1982). The plant is a good soil binder because of its vining stem and rhizomatous root.

This species has numerous vernacular names reported within each country. Butterfly pea (Australia); Mussel-shell creeper (British); Conchita (Spanish); Blue bell (Cayman Islands); Blue pea (Bahamas, Bermuda, Jamaica); Conchita azur, Conctia blanca (Cuba); Pois marron, Pois-poix, Pois sauvage, Pois savane, Pois tonnelle (Guadeloupe); Fula criqua (Portuguese); Campanilla (Panama); Zapatillo de la reina (El Salvador); Pokindang (The Philippine); Papito (Puerto Rico), Aral, Bonga biru, Bunga calente, Kachang telang (Malaysia); Aung-mai-phya, Bukiyu, Pai noung mi (Myanmar); Catharodu, Katarodu, Nil-katarolu (Sri Lanka); Aug chan, (Thailand); Bong biet (Vietnam); Kordofan pea (The Sudan) (Skerman, 1988, and Fantz, 1990,1991 and 1993, Fantz and Predeep, 1995). In ancient Indian literature such as
Amarkosah, Shaligramnighanthu, Dhanvantriniganthu, Laghunighanthu it is well known by several vernacular names viz: Asphota, Girikarnika, Vishnukanta, Aparajita, Chandrakanta, Gokarna, Shankapushpee, Kajali, Girikarni-balli, Neel-aparajita, Nilghiria, Sanka-gida, Shobanjan, Swet-aparajita, Vishnukantisoppu, Vishnukranti etc, (Aiyer and Kolammal, 1964; Fantz and Predeep 1995). It has been considered as a sacred and medicinal plant in our country from the period of puranas. In Matsyapuranas (earlier to 800 A.D) Vishnukanta is described as a medicinal plant, while in Agnipuranas (9th century A. D) Gokarna is mentioned as a holy plant and people used its flowers to worship God Shiva and Durga (Watt, 1989 and Sensarma, 1989). In Tripitaka (500 B.C.-86 A.D) Girikarnika is referred to as a medicinal plant (Mitra, 1974).

**Medicinal Uses:**

**Leaves:**

Leaves are used in the treatment of skin eruptions (Chopra et al., 1949). Juice of the leaves mixed with common salt is used in the treatment of earaches in India especially accompanied by
swollen glands (Kirtikar and Basu, 1918; Mukarji, 1889 and Quisumbing, 1951). Leaf juice mixed with green ginger is used in the treatment of hectic fever (Dastur, 1962; Kirtikar and Basu, 1918 and Quisumbing, 1951). Leaves of the white flower form of C. ternatea are used as poultices in Java (Burkill, 1935; Heyne, 1927 and Quisumbing, 1951). Dastur (1962) reported that, leaves are used in the treatment of ulcers in India and Pakistan.

**Flowers:**

In Cuba flower decoction is used to halt dysentery, and emmenagogue (Morton, 1983). Floral juice of white flowered form of C. ternatea is used in Malaysia to treat inflamed eyes (Burkill, 1935).

**Seeds:**

Seeds are used in the treatment of aperients or mild purgative action. Seeds in powdered form constitute a more useful and a safe medicine than doses of the roots (Chopra et al., 1949). They contain alkaloids (Burkill, 1935; Chopra et al., 1958 and Quisumbing, 1951). Mesa (1945) reported that powdered seeds were administered as laxative to children and are used as a
diuretic. In India and Pakistan roasted seeds are administered to children to cure colic or constipation (Dastur, 1962). Powdered seeds mixed with ginger have been used as diuretic treatment for enlargement of viscera (Jayaweera, 1981) and this powder is also used in the treatment of ascites (Dastur, 1962).

Seeds contain fixed oil and a bitter resinous principle and tannin (Allen and Allen, 1981; Ambasta, 1986; Dymock et al., 1890; Nadkarni, 1927). Seeds are also used in destroying or expelling tape worms (antihelminthic). Duke (1986) reported that the seeds are used in the treatment of cystis and also used as antidotic, diuretic and refrigerant.

*C. ternatea* consists of a toxic constituent which is a hazards to humans and animals (Chopra et al., 1949 and Liener, 1983). This is the only species of the genus previously reported to be used as a dye plant. Ambasta (1986) reported that flowers yield a blue dye, while Kunkel (1984) reported that the “flowers are used as colourants”.
Roots:

The root is used as a diuretic, a treatment for ascites, an accumulation of excess fluids in the abdominal cavity and treating enlargement of the abdominal viscera (Jayaweera, 1981 and Dastur, 1962). Alcoholic extraction of the root used as sedative, analgesic and moderate local anesthesia (Kulkarni et al., 1988). Root bark has been used as a diuretic treatment (Chopra et al., 1958; Kirtikar and Basu, 1918 and Sheriff, 1891). Root juice has been reported to promote nausea and vomiting. Using the root in soup as an emetic is considered a useful treatment in lung ailments and for removing the phlegm in chronic bronchitis. The root juice is used along with cold milk in Concan region of India and Pakistan for the treatment of bronchitis (Dymock, 1885; Kirtikar and Basu, 1918 and Dastur, 1962). Root juice of White flowered form of *C. ternatea* is blown into the nostrils as a treatment for headaches (Hemicarnia) in India and Sri Lanka (Dastur, 1962; Dymock, 1885; Jayaweera, 1981 and Dastur, 1962). The root is reported to be an antidote against snakebites and scorpion-stings in India (Chopra et al., 1949 and 1958 and Duke and Reed, 1981).
Perusal of available literature reveals that the cytological and genetical reports on *C. ternatea* are rather meager and mostly confined to chromosome reports (Federov, 1974; Sanjappa and Dasgupta, 1977; George and George, 1978; Lacky, 1980; Srivastav and Raina, 1980a, and 1982 George and Ninan, 1989; Vijaya, 1990 and Gandhi and Patil, 1994). Studies on inheritance pattern of petal colour and flower form show that blue colour and peloric form flower are dominant and both characters are monogenically controlled (Rant, 1922; Sen and Krishnan, 1961; Chow, 1978). Thombre and Atale (1974) reported that spontaneous mutated gene is pleiotropic, affecting flower form, pigmentation and condition of stamens.

Information about genetic relations among cultivated and wild taxa is of immense value to taxonomists, evolutionists and plant breeders for future utilization of plant species. Investigation on genome relation among taxa of *C. ternatea* is nil. In the present study efforts have been made to systematically characterize the various germplasm with respect to morphological, cytological, breeding analysis, seed protein profile and DNA content to elucidate the following objectives.
• Cytogenetic mechanisms underlying the differentiation pattern within *C. ternatea*.

• Genome homologies, divergence and isolating barriers among various taxa to establish phylogenetic relationship in *C. ternatea*.

• Genome differentiation among spatially isolated *C. ternatea* populations.

• Genome size variation at intraspecific level.

• DNA content variation and species diversification.