Newly Developed Seed Standards of Important Forage Crops

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Towards Fodder - Plus India.....

भाकृअनुप
ICAR

Newly Developed Seed Standards of Important Forage Crops

Lasiurus scindicus
Clitoria ternatea
Desmanthus virgatus
Stylosanthes hamata

Developed by
D. Vijay
Vinod Kumar
R.P. Nagar

भा.च.चा.अ.सं.
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Foreword

The significance of quality seeds in agriculture extends beyond mere increase in production; They embody technological advancements that could catalyze the efficiency of other inputs. In forages, high-quality seeds and planting material could not only plug the gap of fodder unavailability but also improve ecological sustenance and climate resilience of agriculture-based economy through diversification.

The ICAR-Indian Grassland and Fodder Research Institute (IGFRI) in Jhansi has been at the forefront of forage crop research and development. This bulletin encapsulates years of dedicated research and innovation aimed at addressing the critical need for high-quality forage seeds in India. The introduction of seed standards ensures that farmers receive reliable and high-performing seed varieties, which are crucial for enhancing fodder production and supporting the livestock sector. These standards not only guarantee the genetic purity and quality of seeds but also provide a framework for traceability and authenticity through formalizing seed supply, instilling confidence among farmers and stakeholders.

The four tropical grasses highlighted in this bulletin each with their unique attributes and advantages meet the diverse needs of India's agricultural landscape. These grasses are not only resilient to various climatic conditions but also offer superior nutritional value, thereby contributing to the overall sustainability of the farming system. The seed certification and labelling standards detailed in this bulletin outlines the stringent criteria and testing procedures that these grasses have undergone, ensuring that they meet the highest standards of quality and performance.

This bulletin serves as a comprehensive guide for quality regulators and law enforcement agencies, policymakers, researchers, extension workers, and farmers, providing them with the necessary information to make informed decision. By adhering to these standards, stakeholders can significantly enhance forage productivity, mitigate fodder shortages, and improve livestock health and productivity.

The development and dissemination of these seed standards are a testament to IGFRI's commitment to advancing agricultural practices in India. Their efforts align with the broader goal of achieving food security and sustainable agricultural development.

I extend my heartfelt gratitude to the scientists and researchers at IGFRI, whose relentless pursuit has culminated in this valuable resource. This bulletin is not just a document; it is a beacon of progress and a call to action for all those involved in the agricultural sector to adopt and implement these standards, ensuring a sustainable and productive future for India's farming community.

(Pankaj Kaushal)
Director

Foreword

India faces a severe shortage of green fodder for many reasons, and the non-availability of quality seeds is one of the key reasons. India has the potential to develop approximately 80 million hectares of wastelands, range/grasslands, and forest fringes as forage production areas. Nearly 10m ha of permanent pastures are highly degraded and need revitalization. Quality seed of native tropical forage grasses and legumes, the best-disseminating material for unreachable and uncultivable lands, is the most potential and workable option to revitalize these denuded lands. The availability of quality seeds is approximately 10 percent of the requirement for range species. The absence of a generation system of seed production, lack of regular demand and unavailability of seed standards in most tropical range species are some of the important reasons for meager production and availability of quality seed in these species.

Indian Grassland and Fodder Research Institute (IGFRI), a unique institute under the umbrella of the Indian Council of Agriculture Research, constantly strives to bring cutting-edge research and technological interventions to forage crops. IGFRI is the primary producer of forage seeds, especially the range species. The institute produces, on average, 70 t forage seeds annually and was able to spread the seed of range species in 24 states of the country in the last decade. Developing seed standards for forage crops is one of the tasks assigned to this institute.

I am happy that authors have developed seed standards for forage crops for the first time in India. They also provided the detailed methodology followed which will act as a guideline for developing seed standards in other crops. The seed standards developed will have a more significant impact on the four forage crops' seed quality. It will also benefit various stakeholders in getting quality seed material. The enhanced quality will ensure better pricing for the seed, and producing farmers will benefit. The availability of seed standards also encourages systematic seed production through generation systems in forage crops. Further, I extend my heartiest congratulations to all the authors who brought this essential publication on the 63rd Foundation Day of IGFRI.

(Amaresh Chandra)
Former Director

Preface

Quality seed is one of the critical inputs for a thriving agriculture. The seed quality is assured with the help of certain standards for important quality parameters. The Indian Minimum Seed Certification Standards are government-approved standards to be followed to ensure the seed quality of different species used for cultivation. The standards will ensure the availability of quality seed to various stakeholders due to the legal sanctity assured by the Seeds Act of 1966. The Indian Grassland and Fodder Research Institute is one of the few ICAR institutes with a separate division for Seed Technology to cater its services to seed research and seed production of forage species. One of the mandates of the division is to develop seed standards of forage crop species. Several projects were formulated to develop protocols for seed germination and other quality parameters in different forage species. However, none of them could culminate into the formulation of seed standards. In the last few years, with the continuous perseverance of the then Head of Division, Dr. D.R. Malaviya, and three institutional projects were formulated to develop seed standards simultaneously at head quarters Jhansi and regional stations Dharwad and Avikanagar. Three scientists specializing in seed technology were given targets to develop/ revisit the standards in important forage crops. The main difficulty was the non-availability of protocols and proper guidelines or methodology to develop seed standards for these tropical species at the national and international levels.

Further, forage species are challenging to handle because of their indeterminate growth, uneven maturity, small caryopsis, blank seeds, dormancy, several outer appendages and lack of large-scale cultivation. The collection of samples is the most challenging task in the case of forage species. Even though initially several forage crops were targeted, only four crops could make up to the final stage of development of seed standards due to the non-availability of sufficient seed lots. Finally, the standards were developed for *Lasiurus scindicus,* a vital desert grass at IGFRI, Jhansi; for *Clitoriaternatea,* a range legume at IGFRI western regional station Avikanagar; and *Desmanthus virgatus,* a leguminous forages hrub at IGFRI southern regional station Dharwad. The existing standards of *Stylosanthes hamata,* a popular range legume for Indian conditions, were revisited at the Dharwad centre. The statistical analysis for all four crops and document compilation was done at the Jhansi centre.

The detailed methodology followed, samples' details, and protocols developed are furnished in this bulletin. The seed standards developed for the above four tropical forage crops are suitable to be incorporated in the Indian Minimum Seed Certification Standards for extensive general public usage and to reap the commercial benefits by various stakeholders, including farmers. These seed standards developed for the first

time in forage crops under Indian conditions as an outcome of research at IGFRI, Jhansi, will help society by producing and making available quality seeds of these four crops.

The authors sincerely thank colleagues, supporting staff and various authorities, including present and past Heads of the Division of Seed Technology and Directors of IGFRI, for their constant encouragement, support and guidance.

D. Vijay
Vinod Kumar
R.P. Nagar

Contents

Introduction

Range grasses and legumes form an essential component of forage crops. The pastures of grasslands and rangelands worldwide cater to the maximum livestock needs. In India, the grasslands and rangelands are degraded. The grass/rangeland species also play a crucial role in maintaining the region's biodiversity. The diversified growth habitat of the perennial species makes them the only option under challenging terrains and problematic soils. Their ability to withstand and adapt to the changing climate is an additional advantage, making them future-proof. The perennial nature of range species reduces the cost of cultivation, and by adopting specific grazing techniques like protected/rotational grazing, long-term sustainability can be achieved.

The severe competition from food and commercial crops stagnated the area under cultivated fodder crops to a mere 4-5% over several decades. With a mounting 11.24% deficit in green fodder availability for the existing livestock (A.K. Roy *et al.*, 2019), there is a need to focus on sources other than cultivated forage. The rejuvenation of the denuded grasslands and rangelands and utilization of other potential sources (Table 1) lead to the cessation of land constraints and provide an opportunity to reduce the gap between the demand and supply of green fodder to the present and future livestock populations. The success of any cultivation primarily depends on the availability and quality of seed material. The seed requirement for utilising potential grazing resources is huge (0.64 m tonnes). Under the present scenario of lack of seed production resources in range species, meeting even one-tenth of the requirement is arduous.

Table1: Potential land resources for forage cultivation and seed requirement

Potential grazing resources in India	Area (million ha)	Total seed requirement (million tonnes)
Open forest area	30.039	0.2403
Barren and unculturable land	16.948	0.1355
Permanent pastures and other grazing lands	10.258	0.0820
Culturable wasteland	12.388	0.0991
Fallow other than the current fallow	10.694	0.0855
Total	80.327	0.6424

Seed multiplication of range species

The seed multiplication through a formal seed chain is the best way to generate vast quantities of seed in the shortest possible time. For any cultivar to be brought under the generation system of seed multiplication, it should fulfil two primary criteria: 1) the variety shall be released and notified under section 5 of the Seeds Act, and ii) the

availability of field and seed standards for quality maintenance during multiplication. In the case of range grasses and legumes, only a few crops have notified varieties (Table 2), and only a limited number of these varieties are inactive seed production. The lack of availability of standards is another setback for most range species.

Table 2: List of released varieties of different forage range species

Range species	Varieties released
Cenchrus ciliaris	Bundel Anjan-1, Bundel Anjan-4, Bundel Anjan -3, Marwar Anjan, CO-1
Cenchrus setigerus	Marwar Dhaman, Bundel Dhaman 1
Bracharia	DBRS-1
Lasiurus scindicus	Jaisalmeri Sewan (RLSB-11-50)
Dichanthium annulatum	Gujarat Marvel Grass-1, Gujarat Marvel Grass-2, Marvel-7, Marvel-8, Marvel-93, JHD 2013-2
Chrysopogon fulvus	Bundel Dhawlu Ghas-1, Dongari Gawat 2-4-11, GAU D-1
Sehima nervosum	Bundel Sen Ghas-1
Chrloris gayana	Rhodes 10
Setaria sphacelata	Setaria-92, Nandi, PSS-1
Heteropogon contortus	Bundel Lampa Ghas-1
Megathyrsus maximus	Bundel Guinea-1, Bundel Guinea-2, Bundel Guinea-4, Dharwad Guinea grass-1, PGG-616, PGG-1, PGG-9, PGG- 14, PGG-19, PGG-101, PGG-518, PGG-616, Haritha, Marathakam, Harithasree, Riversedale, Hamil, Makueni, CO-1, CO-2, CO-3
Pennisetum pedicellatum (Annual Grass)	Bundel Dinanath-1, Bundel Dinanath-2, Jawahar Pennisetum-12, COD-1 (TNDN-1), Pusa Dinanath Grass
Stylosanthes	Phule Kranti, *Stylosanthes scabra* (Muyal masal)
Guinea	BG1, BG2, DGG 1
Desmanthus virgatus	TNDV-1, TSHL-1

Source: Modified from Database of forage crop varieties (updated edition)

In India, there is no formal seed chain for the multiplication of range species, even after the availability of notified varieties and seed standards for a few grasses and legumes. This is mainly because of a lack of proper policy guidelines to develop and utilise the vast grazing resources available regularly. The grazing resources are mainly common or public property where ownership lies with either the government or people, which leads to a lack of driving force for effective utilisation and rejuvenation of these resources. Until the vast requirement of grass seeds comes under the ambit of the demand and supply system, these ed multiplication of range species through large-scale commercialisation is not possible. Presently, only a limited number of

government organizations and a negligible amount of private entities address the diverse needs for range species seed requirements. The policy decisions for large-scale ventures through public-private partnerships in developing forage resources are the most viable solution for creating the market-driven demand and supply of forage seeds. This will also augment the seed multiplication through the generation system.

Rolling of the seed chain will be possible only if standards are available. The development of seed standards is a time-consuming task. Most of the tropical range species available in our country do not have standards elsewhere. Therefore, the possibility of adopting standards from other sources, as done in many food crops, is ruled out. Thus, we urgently need to develop our own standards for the range grasses and legumes. Even for the available standards of a few species, we must revisit them based on our requirements and situation.

Seed quality

Seed quality refers to genetic purity, germination percentage, vigour, mechanical integrity, disease and pest infection, seed size and appearance of seeds. The determinants of seed quality are purity and germination. Purity and germination are the most critical aspects of normal seed testing and trade. High-quality seeds are a prerequisite in crop production. It pays to invest in high-quality seed, which forms a small percentage of the total input of expenditure in crop production. High-quality seeds are analytically and genetically pure, *i.e.* seeds must not contain other crop or weed seeds, inert matter or other impurities. They germinate readily, are vigorous and have a high percentage of germination. High-quality seeds exhibit mechanical integrity and are devoid of diseases, pests, and physical damage. Moreover, they possess a uniform size with a lustrous clean appearance.

Having realised the characteristics of good-quality seeds, we must also determine what factors can affect seed quality regarding biological and physical properties. Being aware of such factors, we should avoid all the detrimental factors, such as harvesting immature seeds, faulty processing and imperfect storage techniques. All these damaging effects can be detected even by visual examination of seeds and various tests done according to the international seed testing rules. Quality control is the establishment of minimum acceptable standards and formulating and implementing a system and procedures to exceed the required minimum and maintain the standards throughout the production stage.

Although seeds may appear attractive, evenly sized and lustrous, it does not mean they are top quality. The quality evaluation is not subjective; it can be measured quantitatively by approved methods listed in the international rules, such as the germination and purity tests. The genetic purity of seeds is just as important as germination. Good seeds are usually 98-100% pure, while poor quality seeds include many off-types, weeds and other crop seeds in pastures and fodder crops. Some of these weed species are hard and expensive to eradicate and may be poisonous to livestock.

Seed testing

Studies on testing forage seeds are lacking, particularly in developing countries. This is evident from the unavailability and poor quality of these seeds in the local market. All of these arise from seed production and storage difficulty in a hot, humid tropical environment. The shortage of specific harvesting and processing facilities for forage seeds has further worsened the situation. Thus, the quality of tropical forage seeds is often not up to standard compared to temperate species. Most tropical forage grass seeds utilised in developing countries are imported due to several intrinsic seed production problems, *viz.* lack of bred varieties, low seed setting, lodging susceptibility, blank seeds, and absence of mechanical interventions, making them uneconomical to produce. Seed production of these species is minimal, and knowledge and practice of storage and testing for seed quality is consequently meagre. Very few tropical species are listed in the International Rules for Seed Testing. Fortunately, the majority of tropical forage species produce orthodox seeds; hence, the applicable general principles and technology for testing are readily available.

Status of seed certification standards of range forage species

The Indian Minimum Seed Certification Standards (IMSCS) published by the Central Seed Certification Board of the Department of Agriculture, Co-operation and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, Government of India, are the basis for maintaining and making available to the public the quality seeds of various crops including forage species. These standards are also helpful in conducting the seed certification of the foundation and certified seed classes under section 8 of the Seeds Act. Only eight of the twelve range species whose varieties were developed in India possess seed standards. Apart from these, several other potential range species require the development of varieties and standards (Table 3).

Table3: Status of seed standards of some important fodder crops in India and abroad

Important range species	Varieties developed in India	Varieties available in other countries	Seed standards available In India	Seed standards available in other countries
Cenchrus ciliaris	Yes	Yes	Yes	Yes
Cenchrus setigerus	Yes	Yes	Yes	NK
Lasiurus scindicus	Yes	Yes	No	No
Dichanthium annulatum	Yes	Yes	Yes	NK
Chrysopogon fulvus	Yes	Yes	Yes	NK
Sehima nervosum	Yes	Yes	No	NK
Chloris gayana	Yes	Yes	No	Yes

Setaria sphacelata	Yes	Yes	Yes	Yes
Heteropogon contortus	Yes	Yes	No	NK
Megathyrsus maximus	Yes	Yes	Yes	Yes
Pennisetum pedicellatum	Yes	Yes	Yes	NK
Stylosanthes	Yes	Yes	Yes	Yes
Brachiaria decumbens	No	NK	No	Yes
Brachiaria ruzizensis	No	NK	No	Yes
Clitoria ternatea	No	NK	No	NK
Indigo feraastragalina	No	NK	No	NK
Desmodiumintortum	No	NK	No	Yes
Desmodium uncinatum	No	NK	No	Yes
Desmodium tortuosum	No	NK	No	NK
Macroptelium atrapurpureum	No	NK	No	Yes
Atylosia scarabaeoides	No	NK	No	NK
Centrosemapubescens	No	NK	No	Yes
Desmanthus virgatus	Yes	NK	No	NK
Paspalum notatum	No	NK	No	Yes
Bothriochloa intermedia	No	NK	No	NK
Brachia riamutica	No	NK	No	NK
Brachia riabrizantha	No	NK	No	NK
Iseilemalaxum	No	NK	No	NK
Panicum antidotale	No	NK	No	NK
Panicum virgatum	No	Yes	No	Yes
Panicum coloratum	No	NK	No	Yes

NK:Not known

Crops and their Status

The ICAR-Indian Grassland and Fodder Research Institute is a premier research Institute, unique of its kind in Asia, working exclusively on grassland and forage crops with a multi-disciplinary approach. The seed scientists of this institute started working on developing seed standards in the last few years and came up with the standards for the following crops. The crops studied are,

- *Lasiurus scindicus*
- *Clitoria ternatea*
- *Stylosanthes hamata*
- *Desmanthus virgatus*

The developed standards are being submitted to the Ministry of Agriculture and Farmers Welfare for incorporation into the Indian Minimum Seed Certification Standards so that end users can use them successfully.

1. *LASIURUS SCINDICUS*

Botanical name: *Lasiurus scindicus* Henrard

Common name: Sewan Grass

Family: Poaceae (Graminae)

Subfamily: Panicoideae

Tribe: Andropogoneae

Subtribe: Rottboelliinae

About the crop

Lasiurus scindicus is known as *Sewan grass* and is one of the essential arid zone grasses in North-West India. It is a vital forage crop of the desert ecosystem. It is distributed in both Africa and Asia continents. In Africa: Northern African countries *viz.*, Algeria, Libya, Egypt, Morocco, West Tropical African countries, *viz.* Mali and Niger and Northeast Tropical African countries *viz.*, Chad, Ethiopia, Somalia and Sudan. In Asia-temperate: Saudi Arabia, Afghanistan, Iran, Iraq and Israel. In Asia-tropical: India and Pakistan. In India, it is endemic to dry regions of north-west India. The main distribution zone comprises the western part of the Jodhpur district to the Chohtan block in Barmer district and from Nagaur westwards to Bikaner district. Extensive patches of this grass can be seen in Jaisalmer district and the Hummocky sandy plains of the Bikaner district. *Lasiurus scindicus* is a perennial with thin leaf blades and a glaucous stem. The inflorescence is a silky raceme, almost 10 cm long with densely arranged white villous spikelets. At each node of inflorescence, three spikelets, two sessile and one pedicelled, were commonly found.

Importance of the crop

Lasiurus scindicus can grow in desert conditions and is well distributed in the Jaisalmer, Barmer, Bikaner and Jodhpur districts of Rajasthan. It occurs in rainfalls below 250 mm a year. It has excellent drought tolerance capacity and is one of the dominant species in arid zones with as low rainfall as 12.5 mm in Rajasthan. It helps stabilise the dunes in deserts. This plant produces 2700-10500 kg of fresh forage per hectare and has a 1500 kg/ha dry-matter yield.Sewan grass has 7-11% protein content and is highly palatable. It also has moderate tolerance to salinity.

Whether seed standards are already present? If yes, why are they being revisited?

The seed standards for *Lasiurus scindicus* are unavailable at the national and international levels. The standards are being proposed for the first time at the national level.

Major clients of the seed

The major clients include the Forest Department, State Animal Husbandry Department, Highway Development Authority, Biodiversity bodies, Soil Conservation Department and Community pasture development agencies.

Possible quantity of seed trade and its approximate value

Potential seed trade of 40-50 quintals per year with an approximate value of Rs. 25 lakhs per year (based on oral communication with several agencies in Rajasthan, including SKRAU, Bikaner)

***Lasiurus scindicus* field (A)**

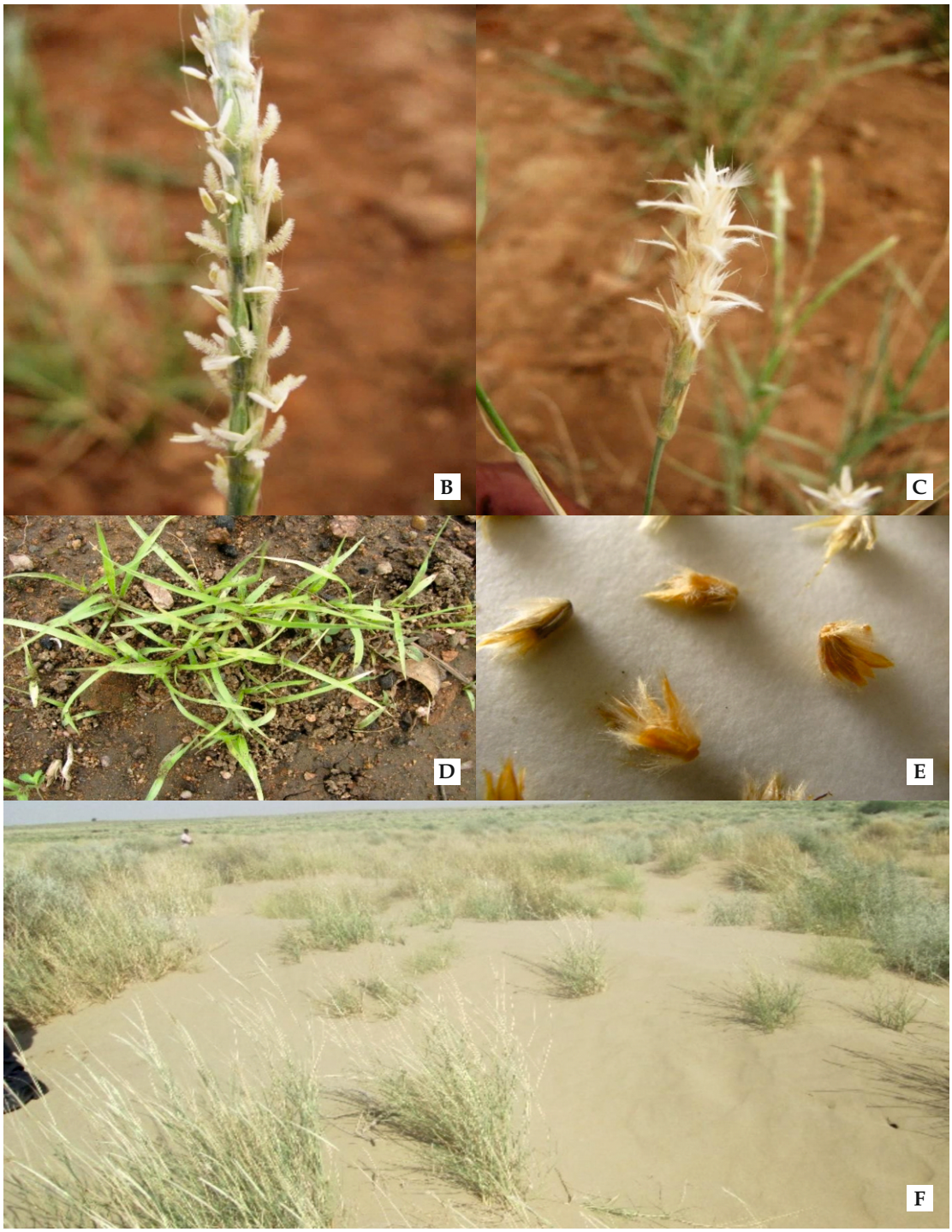


Fig. 1: Inflorescence (B), Dried seed on inflorescence (C), Seedling (D), Seed (E), Crop under natural habitat in Thar desert (F).

2. *CLITORIA TERNATEA*

Botanical name: *Clitoria ternatea* L.

Common name: Butterfly pea

Family: Fabaceae (Leguminosae)

Subfamily: Faboideae

Tribe: Phaseoleae

Subtribe: Clitoriinae

About the crop

Titaly matar, Aprajita (*Clitoria ternatea*) is an important range legume for the nutritional improvement of rangelands under semi-arid regions. It is perennial and hardy, which can survive well under semi-arid conditions on low fertile, sandy soil with limited soil moisture.

Importance of the crop

Clitoria ternatea is perennial and one of the important range legumes. It contains about 16-18% crude protein. It is palatable and liked by grazing animals. It can be grown in arid to semi-arid climates on various soil conditions. It can be grown in pasture in combination with perennial grasses. Thus, *Clitoria* is a vital legume crop for perennial pasture management. The dry matter production potential ranges from 2-3 t/ha with a high digestibility of about 80 per cent.

Whether seed standards are already present? If yes, why are they being revisited?

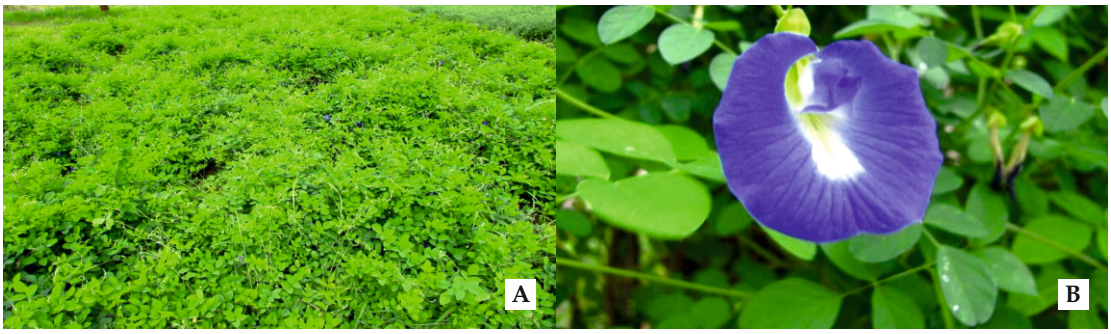
The seed standards for *Clitoria ternatea* are unavailable nationally and internationally. The standards are being proposed for the first time at the national level.

Major clients of the seed

The major clients include the Forest Department, Animal Husbandry Department, Soil Conservation Department, Community pasture development agencies, Goshalas, Commercial dairy farms, Mining corporations, and Highway development agencies.

Possible quantity of seed trade and its approximate value

Potential seed trade of 50-60 quintals per year with an approximate value of Rs. 20-22 lakhs per year (Based on oral communication with several producing agencies).



***Clitoria ternatea* Crop (A), Flower (B)**

Fig. 2: Fruit (C), Seed (D), Seedling (E)

3. *STYLOSANTHES HAMATA*

Botanical name: ***Stylosanthes hamata*** **(L.) Taub**

Common name: Caribbean stylo

Family: Fabaceae (Leguminosae)

Subfamily: Faboideae

Tribe: Aeschynomeneae

Subtribe: Stylosanthinae

About the crop

Stylosanthes is a genus of summer-growing perennial pasture fodder legumes. Most of its species are native to South and Central America and the Caribbean islands. It is a fodder cum leguminous cover crop, which is suited for cultivation as sole or as intercrop. The genus *Stylosanthes* consists entirely of herbs and small shrubs. The crop is suitable for grazing as it usually has a crown of growing points near the soil surface to tolerate excessive animal grazing. The crop is suited for growing in a warm, humid tropical climate. It is fairly drought and shade-tolerant. It can be cultivated in areas receiving less than 1000 mm of rainfall and in less fertile soil, acid soils, gravelly sandy soils, and ill-drained soils.

Caribbean stylo (*S. hamata* cv. Verano): This is a short-lived perennial legume similar to Towns ville stylo. It is slow-growing and develops a flat crown under grazing. The semi-erect stem may grow up to 80 cm. The stems are smooth with fine, short white hairs on one side only.

Importance of the crop (Specific qualities, if any)

These species has many properties that make them valuable forage species. They can fix nitrogen, improve soil fertility, and provide high-protein feed stock. The genus is also noted for its ability to extract phosphorus from soils where it is not available to other species. Seeds are hard and long-lived, leading to high soil seed banks and rapid recovery following fire or heavy grazing. Seed survives passage through the gut of grazing animals and is dispersed widely, allowing for rapid dispersal. Many species are adapted to hot, dry climates and are drought-resistant. These traits have made the genus the world's most widely used tropical pasture legume. *Stylosanthes,* a pioneering coloniser, establishes well on poor and severely eroded soils in dryland conditions. Its ability to improve soil bulk density, infiltration rate, and water-holding capacity makes it a valuable species for conserving land and water resources. *Stylosanthes hamata* is a short-lived perennial legume that has been perceived as perennial due to self-seeding and ratooning.

Whether seed standards are already present? If yes, why are they being revisited?

- The seed standards are available for *Stylosanthes* species and not exclusively for *Stylosanthes hamata*.
- *Stylosanthes hamata* is one of the important and most demanded range legume species.
- The seed is collected manually by sweeping the land. Hence, the seed lot contains higher components of admixtures, stubbles, and weed seeds.
- The non-complying of seed standards is mainly due to production difficulties under Indian conditions.
- All the reasons mentioned above have necessitated revisiting the existing seed standards in the *Stylosanthes hamata*.

Major clients of the seeds

The major clients include the Animal Husbandry Department, Drought-Pprone Area Program, Watershed Committees, Wasteland Development Board, Joint Forest Management/Social Forestry/Forest Department, Horticulture Department, National Highway Development Agencies, NGOs/Rural Development Agencies, Dairy Federations/Unions, Military farms, Sheep growers' federation, Railways, River valley projects and farmers.

Possible quantity of seed trade and its approximate value

No information is available in the public domain.

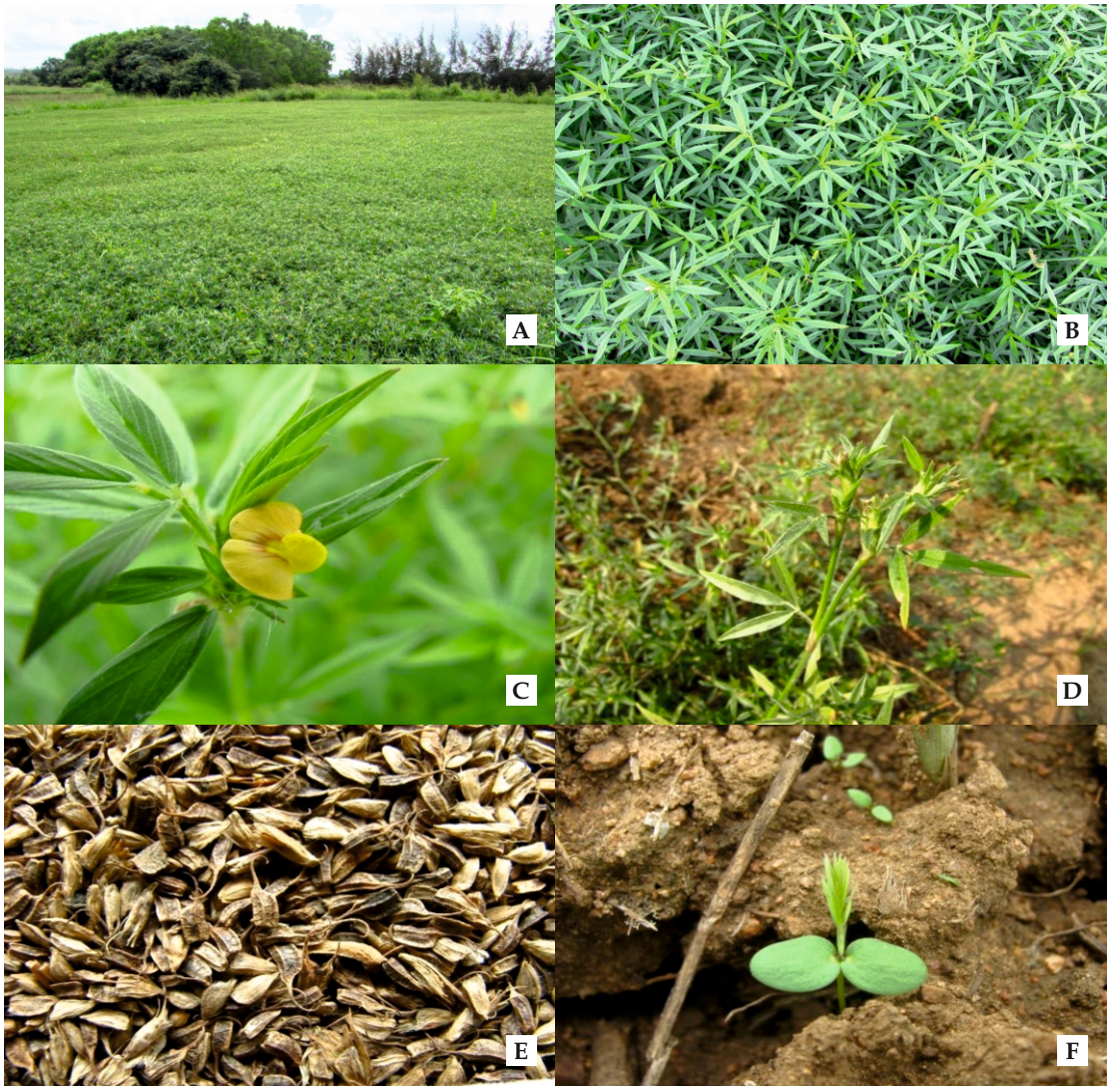


Fig.3: ***Stylosanthes hamata*** **Crop (A-B), Flower (C), Developing seed (D), Seed (E), Seedling (F)**

4. *DESMANTHUS VIRGATUS*

Botanical Name: ***Desmanthus virgatus*** **(L.) Willd.**

Commonname: HedgeLucerne

Family: Fabaceae (Leguminosae)

Subfamily: Mimosoideae

Tribe: Mimoseae

About the crop

Hedge Lucerne is a native of the tropics and subtropics of the New World. It is found throughout the country. It has 18-22% (range) protein in leaves and 10–15% in stems. It is highly productive, yielding about 40-70 tonnes of green fodder per hectare annually. No poisonous component is observed in the foliage. Because of its pithy stem, harvesting is easier. It is an ideal plant for wasteland development.

It is a small shrub, 2–3 m tall, erect, herbaceous, perennial, glabrous with virgate branches. Leaves are bipinnate, 2.4–8 cm long with 6-8 pinnae, 2–9 mm long persistent stipules. Flowers are white, solitary, globose, and peduncled. Pods reddish to golden brown, containing 20-30 seeds and 5-8 cm long.

Importance of the crop (Specific qualities, if any)

It is tolerant and very persistent in low-rainfall environments. It also tolerates heavy grazing. Heavy seed production, even under grazing, can thicken through seedling recruitment. It is tolerant to alkaline clay soils.

Whether seed standards are already present? If yes, why are they being revisited?

No seed standards are available for *Desmanthus virgatus*

Major clients of the seeds:

The major clients include the Animal Husbandry Department, Drought-Prone Area Program, Watershed Committees, Wasteland Development Board, Joint Forest Management/Social Forestry/Forest Department, Horticulture Department, National Highway Development Agencies, NGOs/Rural Development Agencies, Dairy Federations/Unions, Military farms, Sheep growers' federation, Railways/River valley projects and farmers.

Possible quantity of seed trade and its approximate value

No information is available in the public domain.

Fig. 4: ***Desmanthus virgatus*** **Crop (A), Inflorescence (B), Pods (C), Seed (D)**

Methodology Employed

Methodology

Development of suitable protocols: The protocols of seed quality parameters were developed before developing seed standards. The germination, physical purity and moisture content are the three essential components of the standards that require immediate attention. Along with the protocols, the working and submitted sample sizes must be estimated before collecting the seed samples.

Seed collection: The seed sample in sufficient quantities (based on the submitted sample size) was collected from all production or available locations. The standards' reliability depends on including all possible production locations and collecting a greater number of samples. In the case of range species, obtaining samples from different locations was the most challenging task in developing seed standards due to the absence of large-scale cultivation. The samples for moisture were collected separately in a moisture-impervious container.

Seed cleaning: The raw seed collected contains inert matter based on the method of collection, *viz*. bulk harvest, picking or collection from the ground. The collected sample was cleaned by using different sieves to ascertain the physical purity of the seed. The sieve sizes were standardized before employing the cleaning procedure in all the collected samples.

Seed sampling and sample size: The entire seed lot was used to estimate the physical purity of the seed. The sample was obtained from the pure seed fraction to estimate the germination. The working sample size was calculated by taking the weight of 2500 seeds, in grams, from each sample. The data obtained were subjected to frequency analysis, and the sample size with the highest frequency was taken as standard for the working sample. Similarly, the submitted sample size was estimated by multiplying the value of the working sample by ten, followed by frequency analysis. The maximum limit for the submitted sample was fixed as 1000 g.

Physical purity estimation: Physical purity was estimated using the standard method. The identification of pure seed was the most important task in developing seed standards. The pure seed was decided based on the ISTA pure seed definitions by adopting the similar seed definition that was available in the ISTA rules. The pure seed percent of all the samples were estimated and subjected to frequency analysis to obtain the standard.

Germination estimation: The germination was estimated in four replications with 100 seeds in each replication. Initially, the germination methodology was standardised for these four crops in different research projects at the Indian Grassland and Fodder

Research Institute before estimating the germination of different lots and species. The germination and dormancy-breaking treatment durations were standardised before assessing the germination of various species.

Frequency studies: The data obtained for different parameters were subject to frequency analysis to identify the standard. The standard was considered based on the maximum frequency for various parameters. The frequency studies were carried out based on either frequency distribution in uniform class intervals or using frequency density in the case of uneven class intervals. Further, relative frequency and per cent frequency were also estimated to know the percentage of samples falling in the proposed category of highest frequency with maximum probability.

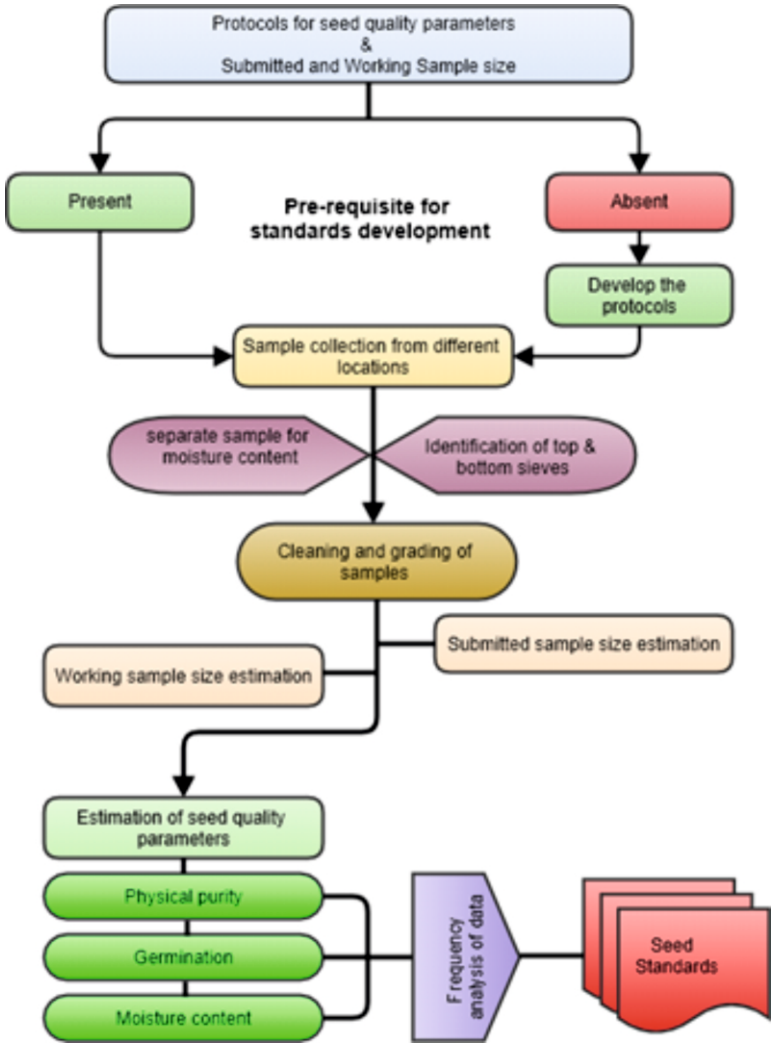


Fig. 5: Flow chart of the methodology

Methodology employed for the targeted crops

I) Sieve sizes used for physical purity

Screens of different sizes were used to separate the pure seed from inert matter. Two sieves, one top sieve and one bottom sieve, were used. The large-size inert matter, chaff, etc. were removed through the upper/top sieve, and a maximum quantity of pure seed was passed through it. The lower/bottom screen was used to separate the undersized seed, dirt, and small-size inert matter that was passed through it, and good seeds were retained. Different sizes of screens were used for different crops, as mentioned in Table 4.

Table 4: Different top and bottom sieve sizes used for separation of pure seed

Crop	Top sieve (mm)	Bottom sieve (mm)
Lasiurus scindicus	4.75 r	3.35 r
Clitoria ternatea	3.60 r	2.50 s
Stylosanthes hamata	2.08 r	1.20 r
Desmanthus virgatus	2.08 r	1.78 r

r=Screen with round perforations; s=Screen with slotted (oblong) perforations

II) Working and submitted sample sizes

The working sample size was finalised based on the frequency analysis of the seed weight of 2500 seeds of each crop species. Similarly, the submitted sample size was completed based on the highest frequency obtained for the test crop species (Table 5).

Table 5: Submitted and working sample size of forage crop species

Crop	Submitted sample size (g)	Working sample size (g)
Lasiurus scindicus	200	20
Clitoria ternatea	1000	110
Stylosanthes hamata	220	22
Desmanthus virgatus	170	17

III) Pure seed definition used for the pure seed fraction

i) The pure seed includes all botanical varieties and cultivars of the species. Seeds were regarded as pure seeds, even if immature, undersized, shrivelled, diseased or germinated, provided they could be identified as seeds of that specific crop species.

ii) Both intact seeds (i.e. seeds in the botanical sense) and pieces resulting from breakage that were more than one-half of their original size were considered pure seeds.

iii) The legume seeds with removed seed coats were regarded as inert matter.

iv) The pure seeds of the given species were defined based on the available Pure Seed Definitions (PSD) provided by ISTA. The most suitable definition was considered for the pure seed of the given species.

a) ***Lasiurus scindicus***

PSD42: Spikelet, with glumesen closing a caryopsis with or without hyaline palea or lemmas, rachis segment(s), pedicel(s), awn(s), attached sterile or fertile floret(s). Floret, with lemma and palea, with or without awn. Caryopsis, a piece of caryopsis larger than one-half the original size.

Lasiurus: spikelet with or without caryopsis.

b) ***Clitoria ternatea***

PSD11: Seed, provided a portion of the testa is attached. Piece of seed larger than one-half the original size provided a portion of the testa is attached.

Fabaceae: cotyledons that are broken a part but held together with in the testa. Seed sand pieces of seed entirely without testa are regarded as inert matter.

Fabaceae: Separated cotyledons are regarded as inert matter, irrespective of whether the radicle-plumule axis and/or more than half of the testa is attached.

c) ***Stylosanthes hamata***

PSD24: Pod, with or without a beak, unless it is obvious that no seed is present. Seed, provided a portion of the testa is attached. Piece of seed larger than one-half the original size, provided a portion of the testa is attached.

d) ***Desmanthus virgatus***

PSD50: Seed, provided a portion of testa is attached, with or without aril. Piece of seed larger than one-half the original size, without wing or integument, provided a portion of the testa is attached.

IV) Germination methodology

The germination test was conducted based on ISTA Rules/guidelines.

1. ***Number of seeds:*** Four hundred seeds were tested for germination. The counting was done by hand without any discrimination in size or appearance.
2. ***Source of seeds*:** Special care was taken to select the 400 seed sub-sample, as per the ISTA Rules. Seeds for the germination test were taken from the 'pure seed' component obtained in physical purity analysis. The seeds were counted without discrimination in size or appearance.

3. ***Germination methods:*** The germination testing methods used in the study are top of the paper (TP) or between paper (BP) or sand (S) according to the crop to find out the best suitable substratum for proper germination. The germination was studied at both constant temperatures of 25 °C and alternate temperatures of 20-30 °C/20-35 °C as per the crop to find the best suitable temperature for the test. Similarly, the requirement of light during germination was studied by exposing the germinating seeds under light and darkness at constant temperature, with light at high temperature and darkness at low temperature in case of alternate temperature.
4. ***Dormancy-breaking methods:*** After standardising the germination methodology, different treatments were tested for different crop species to find out the most suitable dormancy-breaking treatment. Based on the type of dormancy, various treatments were imposed. In species with physiological dormancy, 0.2% KNO3 and 0.05% GA3 were tested to break the dormancy, and for physical dormancy, different scarification methods, viz. mechanical, acid, physical and chemical scarification, were employed.
5. ***Germination protocol:*** Based on different experiments on substratum, temperature, light requirement, consumption of food materials and dormancy-breaking treatments, the finalized protocols, as provided in Table 6, were used for developing seed germination standards of different forage crop species.

Table 6: Final germination protocol used for testing the forage crop species

Crop	Germination test duration		Recommended Temperature	Substratum/ method of test	Dormancy-breaking treatment, if any
	First count	Final count			
Lasiurus scindicus	12	22	20-35°C	TP	17 h soaking in 500 ppm Ga_3
Clitoria ternatea	7	10	20-30°C	BP	Nicking/Sand paper scarification
Stylosanthes hamata	7	21	25-30°C	TP/BP	Mechanical scarification
Desmanthus virgatus	7	21	20-30°C	TP	H_2SO_4 for one minute/ Hot water treatment for 5 minutes

V) Germination evaluation

The germination duration was standardised based on the exhaustion of food material and dormancy treatment. After germination, the seeds/seedlings were divided into five categories: normal seedlings, abnormal seedlings, hard seeds, fresh un-germinated seeds and dead seeds based on the crop tested. The germination percentage was recorded based on the percentage of normal seedlings to the total seeds used for the germination test in the case of grasses. In legumes, the germination percentage was calculated by adding per cent normal seedlings and per cent hard seeds of the samples.

Crop-wise Sample Details

1. *LASIURUS SCINDICUS*

Number of samples collected and their location

A total of 83 samples were collected from different locations in Rajasthan state. Details of samples collected from different locations are as below (Table 7).

Table7: Collection location details of *Lasiurus scindicus* samples used in the study

Sample No.	Location	District	State	Latitude (dd)	Longitude (dd)	Altitude (m)
1	Kharafarm	Bikaner	Rajasthan	28.198039	73.384258	205
2	Kharafarm	Bikaner	Rajasthan	28.198159	73.384258	205
3	Mulana	Jaisalmer	Rajasthan	26.778529	71.329275	252
4	Badora	Jaisalmer	Rajasthan	26.905900	71.174627	222
5	Jerat	Jaisalmer	Rajasthan	26.872829	71.113741	231
6	Jerat	Jaisalmer	Rajasthan	26.872765	71.112945	231
7	Kharafarm	Bikaner	Rajasthan	28.198062	73.384759	205
8	Basanper	Jaisalmer	Rajasthan	26.887520	71.069177	201
9	Jerat	Jaisalmer	Rajasthan	26.872569	71.113994	231
10	Chandenfarm CAZRI	Jaisalmer	Rajasthan	26.994821	71.334980	191
11	Chandenfarm CAZRI	Jaisalmer	Rajasthan	26.994814	71.334860	191
12	10 JMD	Bikaner	Rajasthan	28.210783	73.299656	192
13	Kharafarm	Bikaner	Rajasthan	28.198135	73.385526	205
14	10 JMD	Bikaner	Rajasthan	28.210780	73.299637	192
15	10 JMD	Bikaner	Rajasthan	28.210764	73.299673	192
16	Jerat	Jaisalmer	Rajasthan	26.872655	71.113485	231
17	Chanden	Jaisalmer	Rajasthan	26.994756	71.334920	191
18	Kharafarm	Bikaner	Rajasthan	28.198456	73.384658	205
19	Basanper	Jaisalmer	Rajasthan	26.887620	71.069173	201
20	Badora	Jaisalmer	Rajasthan	26.906500	71.174639	222
21	Basanper	Jaisalmer	Rajasthan	26.887460	71.069179	201
22	Jerat	Jaisalmer	Rajasthan	26.872458	71.113256	231
23	Badora	Jaisalmer	Rajasthan	26.904700	71.174621	222
24	10 JMD2	Bikaner	Rajasthan	28.208595	73.299672	192

25	Kharafarm	Bikaner	Rajasthan	28.203525	73.343176	198
26	Mulana	Jaisalmer	Rajasthan	26.778506	71.329299	252
27	Kharafarm	Bikaner	Rajasthan	28.203224	73.343722	198
28	Jerat	Jaisalmer	Rajasthan	26.873000	71.112294	218
29	Basanper	Jaisalmer	Rajasthan	26.887410	71.069167	201
30	Chandenfarm CAZRI	Jaisalmer	Rajasthan	26.994824	71.334920	191
31	Kharafarm	Bikaner	Rajasthan	28.203952	73.343426	198
32	10 JMD	Bikaner	Rajasthan	28.210758	73.299641	192
33	Mulana	Jaisalmer	Rajasthan	26.778553	71.329252	252
34	Devikot	Jaisalmer	Rajasthan	26.702686	71.231091	289
35	10 JMD	Bikaner	Rajasthan	28.210776	73.299699	192
36	Badora	Jaisalmer	Rajasthan	26.905100	71.174634	222
37	Chandenfarm	Jaisalmer	Rajasthan	26.995829	71.335600	200
38	Chandenfarm	Jaisalmer	Rajasthan	26.995834	71.335542	200
39	Chandenfarm	Jaisalmer	Rajasthan	26.995831	71.335621	200
40	AICRP field	Bikaner	Rajasthan	28.096608	73.351326	252
41	Sehua Desert	Jaisalmer	Rajasthan	27.482862	70.633797	143
42	Sehua Desert Tejpal	Jaisalmer	Rajasthan	27.574264	70.709703	133
43	Sultana	Jaisalmer	Rajasthan	27.614624	70.912594	138
44	Sultana	Jaisalmer	Rajasthan	27.614026	70.912575	138
45	Sehua Desert	Jaisalmer	Rajasthan	27.482764	70.633759	143
46	Bada	Jaisalmer	Rajasthan	27.593580	70.860058	129
47	Sehua Desert	Jaisalmer	Rajasthan	27.482543	70.633691	143
48	Kamini Village	Bikaner	Rajasthan	28.141871	73.102538	199
49	Sehua Desert Tejpal	Jaisalmer	Rajasthan	27.574365	70.709512	133
50	Sehua Desert Tejpal	Jaisalmer	Rajasthan	27.562886	70.680131	135
51	Sehua Desert	Jaisalmer	Rajasthan	27.482815	70.633771	143
52	Sultana	Jaisalmer	Rajasthan	27.573986	70.903986	132
53	Sehua Desert	Jaisalmer	Rajasthan	27.482853	70.633683	143
54	Bada	Jaisalmer	Rajasthan	27.593650	70.860045	129
55	26 JMD Kangse Vill	Bikaner	Rajasthan	28.166190	73.112578	178
56	Sehua Desert Tejpal	Jaisalmer	Rajasthan	27.562866	70.680105	135

57	Kamini Road	Bikaner	Rajasthan	28.106730	73.133878	224
58	Kamini Village	Bikaner	Rajasthan	28.141246	73.102359	199
59	Kamini Village	Bikaner	Rajasthan	28.141359	73.102654	199
60	ARS Forage Block 1	Bikaner	Rajasthan	28.096377	73.351286	235
61	Bada	Jaisalmer	Rajasthan	27.593440	70.860069	129
62	ARS -Sweeping	Bikaner	Rajasthan	28.097335	73.352377	238
63	Kamininear Nal	Bikaner	Rajasthan	28.106679	73.141817	212
64	Kamininear Nal	Bikaner	Rajasthan	28.106683	73.141852	212
65	ARS Forage Block 2	Bikaner	Rajasthan	28.096875	73.351582	235
66	Sehua Desert Tejpal	Jaisalmer	Rajasthan	27.579223	70.754916	129
67	Kharafarm	Bikaner	Rajasthan	28.203763	73.343569	198
68	ARS Orchard Block	Bikaner	Rajasthan	28.100550	73.349740	232
69	Kangse Village	Bikaner	Rajasthan	28.169550	73.112721	178
70	ARS Orchard Block	Bikaner	Rajasthan	28.100180	73.349630	232
71	ARS	Bikaner	Rajasthan	28.096608	73.351326	252
72	Sehua Desert	Jaisalmer	Rajasthan	27.482652	70.633811	143
73	Kamini Village	Bikaner	Rajasthan	28.141254	73.102469	199
74	Kangse Village	Bikaner	Rajasthan	28.169538	73.112754	178
75	Forage Unit	Bikaner	Rajasthan	28.073514	73.342655	229
76	AICRP field	Bikaner	Rajasthan	28.096608	73.351326	252
77	NearBap Village	Bikaner	Rajasthan	27.525881	72.509393	211
78	Kamini Village	Bikaner	Rajasthan	28.141556	73.102156	199
79	Bhuttaewala	Jaisalmer	Rajasthan	27.621860	70.814565	138
80	Suttana	Jaisalmer	Rajasthan	27.573852	70.903885	132
81	Sehua	Jaisalmer	Rajasthan	27.487049	70.629361	143
82	Sehua	Jaisalmer	Rajasthan	27.487052	70.629292	143
83	Sehua	Jaisalmer	Rajasthan	27.487063	70.629347	143

dd: decimal degrees; m= meters; ARS = Agricultural Research Station, AICRP = All India Coordinated Research Project; CAZRI=Central Arid Zone Research Institute

WorkingandSubmittedsamplesizes

The working sample size estimated for *Lasiurus scindicus* based on the frequency analysis of samples collected from different locations is 20g, while the submitted sample size is 200g.

2. *CLITORIA TERNATEA*

Number of samples collected and their location

A total of 54 samples were collected from 9 different locations in Rajasthan, UP, Gujarat, Karnataka and TamilNadu states (Table 8)

Table 8: Collection location details of *Clitoria ternatea* samples used in the study

Location	District	State	Latitude (dd)	Longitude (dd)	Elevation (m)
Avikanagar	Tonk	Rajasthan	26.310833	75.430277	343
IGFRI	Jhansi	UttarPradesh	25.526388	78.546944	224
IGFRI Reg. Station	Dharwad	Karnataka	15.484444	74.976388	686
CAZRI Reg. Station	Bhuj	Gujarat	23.213055	69.793611	127
AAU	Anand	Gujarat	22.534166	72.967777	40
RAU	Bikaner	Rajasthan	28.092777	73.351944	224
Panamarathupatty	Namakkal	Tamil Nadu	11.078611	78.134722	124
Namakkal	Namakkal	Tamil Nadu	11.279722	78.112777	197
Hatki, Tesh. - Malpura	Tonk	Rajasthan	26.312500	75.347777	331

dd: decimal degrees; m= meters; IGFRI = Indian Grassland and Fodder Research Institute; Reg.=Regional; CAZRI=Central Arid Zone Research Institute; AAU=Anand Agricultural University, RAU=Rajasthan Agricultural University

Working and submitted sample sizes

The working sample size estimated for *Clitoria ternatea* based on the frequency analysis of samples collected from different locations is 110g, while the submitted sample size is 1000 g.

3. *STYLOSANTHES HAMATA*

Number of samples collected and their location

A total of 51 samples were collected from different locations in Andhra Pradesh, Uttar Pradesh, Kerala, Karnataka, and Gujarat. Details of samples collected from different locations are as below (Table 9).

Table 9: Collection location details of *Stylosanthes hamata* samples used in the study

Sample No.	Location	District	State	Latitude (dd)	Longitude (dd)	Altitude (m)
1	Vadapalli	Anantpur	Andhra Pradesh	16.815430	81.812870	210
2	Vadigepalli	Anantpur	Andhra Pradesh	13.945178	77.694036	214
3	Devulacheruvu	Anantpur	Andhra Pradesh	13.944301	77.702439	206
4	Pulgurlapalli	Anantpur	Andhra Pradesh	13.930074	77.689135	206
5	Pulgurlapalli	Anantpur	Andhra Pradesh	13.928840	77.689886	206

6	Pulgurlapalli	Anantpur	Andhra Pradesh	13.929522	77.688604	206
7	Pulgurlapalli	Anantpur	Andhra Pradesh	13.928698	77.689022	206
8	Pulgurlapalli	Anantpur	Andhra Pradesh	13.928475	77.689762	206
9	Pulgurlapalli	Anantpur	Andhra Pradesh	13.930420	77.688894	206
10	Pulgurlapalli	Anantpur	Andhra Pradesh	13.929478	77.687316	206
11	Pulgurlapalli	Anantpur	Andhra Pradesh	13.928947	77.689380	206
12	Gollapalli	Anantpur	Andhra Pradesh	13.942973	77.675641	216
13	Gorantla	Anantpur	Andhra Pradesh	13.989068	77.775644	216
14	Devalacheruvapalli	Anantpur	Andhra Pradesh	13.936954	77.695603	213
15	Idaballapuram	Anantpur	Andhra Pradesh	13.924541	77.672687	206
16	Guttuvarpalli	Anantpur	Andhra Pradesh	13.980345	77.688293	217
17	Palasamudram	Anantpur	Andhra Pradesh	13.961285	77.679327	209
18	Palasamudram	Anantpur	Andhra Pradesh	13.959161	77.678361	209
19	Palasamudram	Anantpur	Andhra Pradesh	13.962234	77.680966	209
20	Palasamudram	Anantpur	Andhra Pradesh	13.962061	77.677853	209
21	Palasamudram	Anantpur	Andhra Pradesh	13.960154	77.671984	209
22	Palasamudram	Anantpur	Andhra Pradesh	13.964513	77.671499	209
23	Palasamudram	Anantpur	Andhra Pradesh	13.956885	77.674408	209
24	Palasamudram	Anantpur	Andhra Pradesh	13.961120	77.673999	209
25	Palasamudram	Anantpur	Andhra Pradesh	13.957554	77.677253	209
26	Palasamudram	Anantpur	Andhra Pradesh	13.956403	77.673256	209
27	Budapalli	Anantpur	Andhra Pradesh	13.953706	77.693465	216
28	Tammanayanapalli	Anantpur	Andhra Pradesh	13.948375	77.707799	217
29	Brahmanpalli	Anantpur	Andhra Pradesh	13.929341	77.715867	224
30	Malapalli	Anantpur	Andhra Pradesh	13.955225	77.696897	210
31	IGFRI	Jhansi	Uttar Pradesh	25.526388	78.546944	224
32	IGFRI	Jhansi	Uttar Pradesh	25.853888	78.893611	223
33	KLDB	Dhoni	Kerala	10.816032	76.635053	156
34	RSFPD	Bangalore	Karnataka	13.166691	77.472597	861
35	RSFPD	Bangalore	Karnataka	13.159107	77.470495	861
36	RSFPD	Bangalore	Karnataka	13.159405	77.465677	861
37	AAU	Anand	Gujarat	22.534166	72.967777	40
38	IGFRI Reg. Station	Dharwad	Karnataka	15.484387	74.976523	686
39	IGFRI Reg. Station	Dharwad	Karnataka	15.485013	74.976751	686
40	IGFRI Reg. Station	Dharwad	Karnataka	15.484787	74.976155	686
41	IGFRI Reg. Station	Dharwad	Karnataka	15.484213	74.976372	686
42	IGFRI Reg. Station	Dharwad	Karnataka	15.554915	74.824178	686

43	IGFRI Reg. Station	Dharwad	Karnataka	15.554912	74.824141	686
44	IGFRI Reg. Station	Dharwad	Karnataka	15.550760	74.809051	686
45	IGFRI Reg. Station	Dharwad	Karnataka	15.549282	74.809574	686
46	IGFRI Reg. Station	Dharwad	Karnataka	15.548824	74.809637	686
47	IGFRI Reg. Station	Dharwad	Karnataka	15.548455	74.810051	686
48	IGFRI Reg. Station	Dharwad	Karnataka	15.548010	74.810238	686
49	IGFRI Reg. Station	Dharwad	Karnataka	15.547608	74.810302	686
50	IGFRI Reg. Station	Dharwad	Karnataka	15.547044	74.810535	686
51	IGFRI Reg. Station	Dharwad	Karnataka	15.548929	74.809117	686

IGFRI=Indian Grassland and Fodder Research Institute; KLDB=Kerala Livestock Development Board; RSFPD = Regional Station for Fodder Production and Development; AAU=Anand Agricultural University; Reg.=Regional

Working and submitted sample sizes

The working sample size estimated for *Stylosanthes hamata* based on the frequency analysis of samples collected from different locations is 22 g, while the submitted sample size is 220 g.

4. *DESMANTHUS VIRGATUS*

Number of samples collected and their location

A total of 42 samples were collected from different locations in Tamil Nadu, Maharashtra, Uttar Pradesh, Karnataka, and Gujarat. Details of samples collected from different locations are below (Table 10).

Table 10: Collection location details of *Desmanthus virgatus* samples used in the study

Sample No.	Location	District	State	Latitude (dd)	Longitude (dd)	Altitude (m)
1	KVK	Namakkal	Tamil Nadu	11.155050	78.161558	186
2	KVK	Namakkal	Tamil Nadu	11.154987	78.161257	186
3	KVK	Namakkal	Tamil Nadu	11.155345	78.160729	186
4	KVK	Namakkal	Tamil Nadu	11.154628	78.161743	186
5	KVK	Namakkal	Tamil Nadu	11.155082	78.160515	186
6	KVK	Namakkal	Tamil Nadu	11.155534	78.159817	186
7	KVK	Namakkal	Tamil Nadu	11.155860	78.159827	186
8	Veterinarycollege	Namakkal	Tamil Nadu	11.156279	78.160908	186
9	Veterinarycollege	Namakkal	Tamil Nadu	11.156373	78.159303	186
10	Veterinarycollege	Namakkal	Tamil Nadu	11.156257	78.158725	186
11	Veterinarycollege	Namakkal	Tamil Nadu	11.156655	78.158715	186
12	Panamarathupatty	Namakkal	Tamil Nadu	11.078722	78.134563	125
13	Panamarathupatty	Namakkal	Tamil Nadu	11.078334	78.133986	125

14	Panamarathupatty	Namakkal	Tamil Nadu	11.076790	78.133843	125
15	Kerayur	Namakkal	Tamil Nadu	11.074076	78.135415	120
16	Maniyangalipatty	Namakkal	Tamil Nadu	11.080808	78.141089	124
17	Maniyangalipatty	Namakkal	Tamil Nadu	11.080540	78.142604	124
18	Maniyangalipatty	Namakkal	Tamil Nadu	11.082447	78.140747	124
19	Maniyangalipatty	Namakkal	Tamil Nadu	11.080718	78.142604	124
20	Namakkal	Namakkal	Tamil Nadu	11.146142	78.164039	199
21	MelEachavari	Namakkal	Tamil Nadu	11.152630	78.172777	179
22	MelEachavari	Namakkal	Tamil Nadu	11.150563	78.175654	179
23	Kalliyangadu	Namakkal	Tamil Nadu	11.150103	78.137395	174
24	NARI	Phaltan	Maharashtra	18.003037	74.397540	567
25	NARI	Phaltan	Maharashtra	18.003404	74.397973	567
26	IGFRI	Jhansi	Uttar Pradesh	25.526388	78.546944	224
27	IGFRI	Jhansi	Uttar Pradesh	25.853888	78.893611	223
28	IGFRIReg.Station	Dharwad	Karnataka	15.484387	74.976523	686
29	IGFRIReg.Station	Dharwad	Karnataka	15.485013	74.976751	686
30	IGFRIReg.Station	Dharwad	Karnataka	15.484787	74.976155	686
31	IGFRIReg.Station	Dharwad	Karnataka	15.484213	74.976372	686
32	IGFRIReg.Station	Dharwad	Karnataka	15.554915	74.824178	686
33	IGFRIReg.Station	Dharwad	Karnataka	15.554912	74.824141	686
34	IGFRIReg.Station	Dharwad	Karnataka	15.550760	74.809051	700
35	IGFRIReg.Station	Dharwad	Karnataka	15.549282	74.809574	700
36	IGFRIReg.Station	Dharwad	Karnataka	15.548824	74.809637	700
37	IGFRIReg.Station	Dharwad	Karnataka	15.548455	74.810051	700
38	IGFRIReg.Station	Dharwad	Karnataka	15.548010	74.810238	700
39	IGFRIReg.Station	Dharwad	Karnataka	15.547608	74.810302	700
40	AAU	Anand	Gujarat	22.534166	72.967777	40
41	Kamplikop	Dharwad	Karnataka	15.205241	75.114101	613
42	Kamplikop	Dharwad	Karnataka	15.208456	75.112596	613

KVK = Krishi Vigyan Kendra; NARI = Nimbkar Agricultural Research Institute; IGFRI Indian Grassland and Fodder Research Institute; Reg.=Regional; AAU=Anand Agricultural University

Working and submitted sample sizes

The working sample size estimated for *Desmanthus virgatus* based on the frequency analysis of samples collected from different locations is 17 g. Whereas the submitted sample size is 170 g.

Frequency Analysis

The frequency analysis was done for all samples collected under each crop to arrive at the most frequent data point. The following procedure was followed.

- The collected data was organised into different groups known as classes.
- The class size or class interval was estimated using the following formula and rounded to the nearest whole number.

$$Class\ Intervals = \frac{Maximum\ value\text{-}Minimum\ Value}{No.\ of\ classes}$$

- A class interval is always a whole number.
- All the classes may have the same or different class sizes depending on the data requirement.
- The frequency of the data was calculated by counting the number of samples that fall in that class interval.
- The lower and upper-class limits were decided based on the minimum value and class interval.
- The lower-class limit should be either equal to or less than the minimum value of the sample.
- The upper-class limit was arrived at by adding the class interval to the lower-class limit.
- The class boundaries helped check which class the sample data would fit.

  Upper class boundary = Upper class limit + 0.5

  Lower class boundary = Lower class limit – 0.5

- After calculating the frequency of the data, the relative frequency and percent frequency were calculated as explained below.
- The histogram is prepared based on frequency data (for equal class intervals) and frequency density(for unequal class intervals).
- The class interval with maximum frequency or frequency density was used to decide the standard for a given parameter.
- For standards with minimum limits, the lower-class limit of the class interval with the highest frequency was taken as the standard for that parameter.

- For standards with a maximum limit, the upper-class limit of the class interval with the highest frequency was taken as the standard for that parameter.

  Frequency density: When the classes have unequal width, the frequency will give absurd results. The frequency density was obtained by dividing the frequency by the class interval to get the highest frequency of that class interval.

  Relative frequency: The relative frequency was estimated by dividing the frequency of each class by the total number of observations, i.e., the sum of frequencies of all the classes. It gives the proportion of samples that fall in that class interval or simply the probability of the sample.

  Per cent frequency: It was obtained by multiplying the relative frequency with 100. This parameter will give the percentage of samples falling in that class interval.

Examples of frequency analysis:

I. Frequency Analysis of the working sample size of *Lasiurus scindicus*

a) Class interval estimation

Maximum value of working sample size = 24.38 Minimum value of working sample size = 8.30

$$Class\ Intervals = \frac{Maximum\ value\text{-}Minimum\ Value}{No.\ of\ classes}$$

$$=(24.38 - 8.30)/\ 10 = 1.608$$

The class interval was rounded to the nearest whole no.,i.e. '**2**'

b) Frequency analysis of the data (Table 11).

Table 11: Frequency details of working sample size in *Lasiurs scindicus*

Class group	Frequency	Relative frequency	Percent frequency
8-10	1	0.012	1.23
10-12	1	0.012	1.23
12-14	1	0.012	1.23
14-16	16	0.198	19.75
16-18	30	0.370	37.04
18-20	24	0.296	29.63
20-22	7	0.086	8.64
22-24	0	0.000	0.00
24-26	1	0.012	1.23

c) Frequency distribution

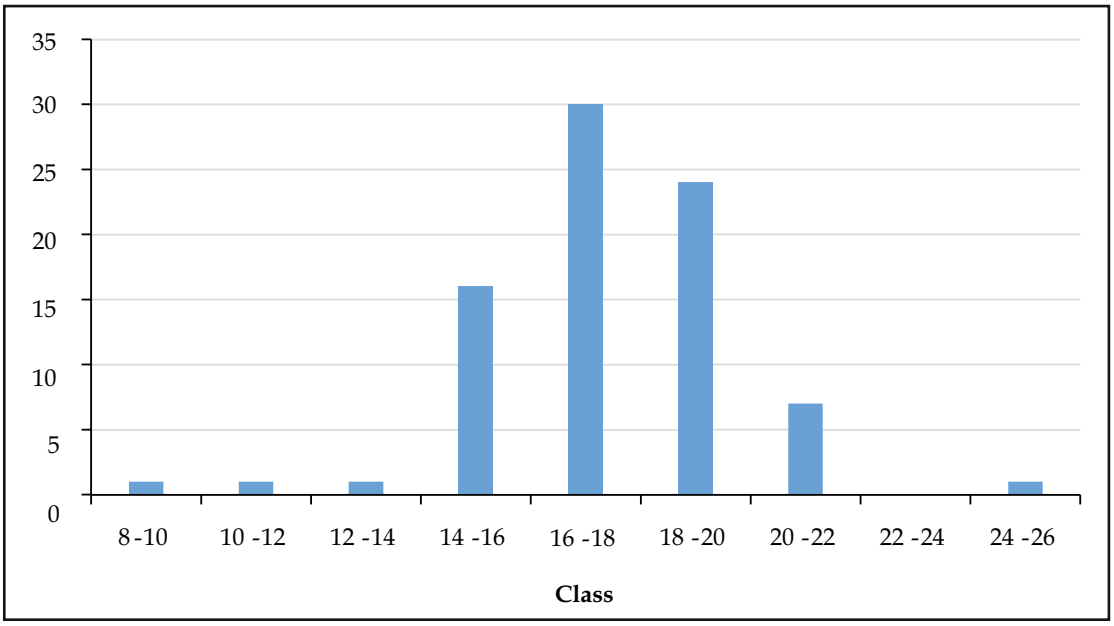


Fig. 6 Frequency details of working sample size in *Lasiurs scindicus*

a) ***Statement***: The frequency analysis indicates that 37% of samples have a working sample size of 16 g or above but less than 18 g, and the probability of a randomly selected sample having a working sample size in this range is 0.37, which is the highest probability for any class (Table 11). The working sample size can be taken as the higher value of class interval, i.e. 18 g.

b) ***Conclusion***: The finalised working sample size for *Lasiurus scindicus* is 20 g after rounding off the analysed value (18g) to the nearest multiple of10.

II. Frequency Analysis of germination % of *Desmanthus virgatus*

a. Class interval estimation

Maximum value of germination % = 99 Minimum value of germination % = 75.8

$$Class\ Intervals = \frac{Maximum\ value\text{-}Minimum\ Value}{No.\ of\ classes}$$

$$=(99 - 75.8)/15 = 1.54$$

The class interval was rounded to the nearest whole no., i.e. '**2.**'

The variable class interval was chosen for the class group due to the requirement for more precision in germination percentage analysis. The class interval of '1' was chosen from 95 to 100.

Frequency analysis of the data (Table 12).

Table 12: Frequency details of germination percentage in *Desmanthus virgatus*

Class group	Frequency	Frequency density	Relative frequency	Per cent frequency
75-77	3	1.5	0.045	4.55
77-79	1	0.5	0.015	1.52
79-81	0	0	0.000	0.00
81-83	1	0.5	0.015	1.52
83-85	2	1	0.030	3.03
85-87	1	0.5	0.015	1.52
87-89	2	1	0.030	3.03
89-91	1	0.5	0.015	1.52
91-93	2	1	0.030	3.03
93-95	5	2.5	0.076	7.58
95-96	6	6	0.182	18.18
96-97	5	5	0.152	15.15
97-98	5	5	0.152	15.15
98-99	8	8	0.242	24.24
99-100	0	0	0.000	0.00

c) Frequency distribution

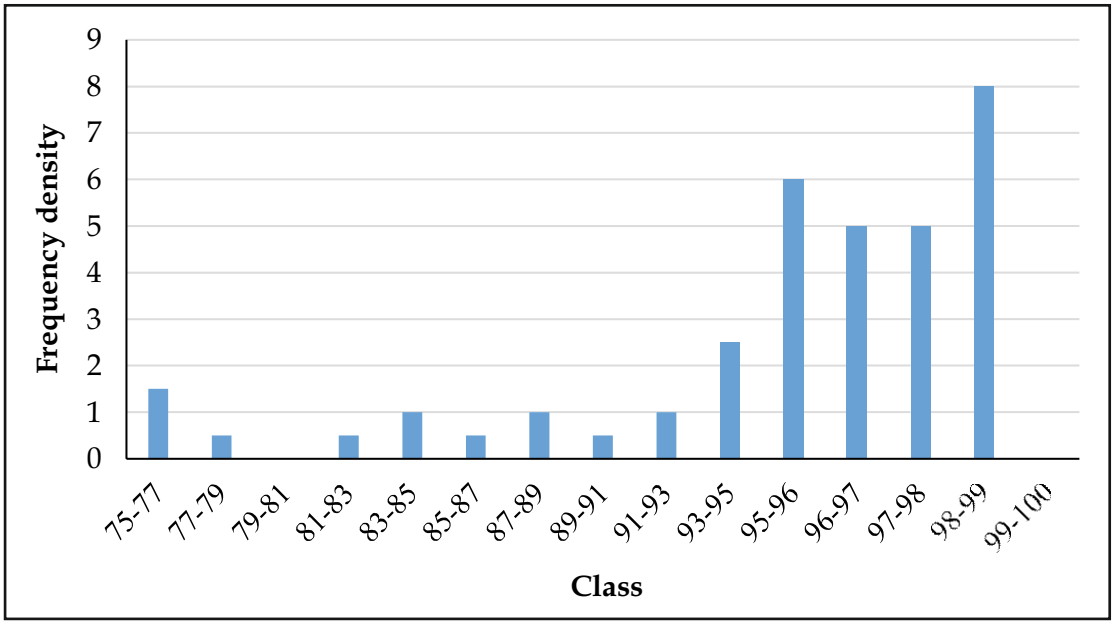


Fig. 7. Frequency details of germination percentage in *Desmanthus virgatus*

d. ***Statement***: The frequency analysis indicates that 24% of samples have a 98% or above germination percentage but less than 99%. The probability of a randomly selected sample having germination in this range is 0.24, the highest probability for any class (Table 12). The lower value of this class group, i.e., 98%, can be considered for the minimum certification standard for germination of *Desmanthus virgatus* seed.

e. ***Conclusion***: The finalised germination standard for *Desmanthus virgatus* seed (including hard seeds) is 98%.

PROPOSED SEED STANDARDS

Proposed Seed Standards of *Lasiurus Scindicus* (*Sewan* grass)

The standards are proposed for the first time based on the frequency analysis of the samples collected from different *Lasiurus scindicus* growing areas of India. The field standards are based on the standards of similar and nearest crop species.

I. Application and Amplification of General Seed Certification Standards

The General Seed Certification Standards are basic and, to gather with the following specific standards, constitute the standards for certification of the seeds of *sewan* grass.

II. Land Requirements

A. Foundation seed

A seed crop of *sewan* grass shall not be eligible for certification if planted on land on which the same kind of crop was grown within the previous five crop seasons.

B. Certified seed

Land to be used for seed production of *sewan* grass shall be free of volunteer plants.

III. Field Inspection

A minimum of three inspections shall be made, the first be for flowering, these second during flowering and the third at maturity and before harvesting.

IV. Field Standards (based on the nearest crop)

A. General requirements

1. Isolation

Seed fields shall be isolated from the contaminants shown in column 1 of the Table below by the distances specified in column 2 and 3 of the said Table.

Contaminants	Minimum distance (meters)	
	Foundation	Certified
Fields of other varieties of the same spp.	20	10
Fields of the same variety not conforming to varietal purity requirements for certification	20	10

B. Specific requirements

Factor	Maximum permitted (%)*	
	Foundation	Certified
Off-types	0.10	1.0

*Maximum permitted at and after flowering.

V. Seed Standards

Factor	Standards for each class	
	Foundation	Certified
Pure seed (minimum)	75.0%	75.0%
Inert matter (maximum)	25.0%	25.0%
Other crop seeds (maximum)	20/kg	40/kg
Weed seeds (maximum)	20/kg	40/kg
Germination (minimum)	20%	20%
Moisture (maximum)	11.0%	11.0%
For vapour-proof containers (maximum)	8.0%	8.0%

Proposed Seed Standards of *Clitoria Ternatea* (*Titaly matar*)

The standards are proposed for the first time based on the frequency analysis of the samples collected from different *Clitoria ternatea* growing areas of India. The field standards are based on the standards of similar and nearest crop species.

I. Application and Amplification of General Seed Certification Standards

The General Seed Certification Standards are basic and, together with the following specific standards, constitute the standards for certification of the seeds of Titaly matar.

II. Land Requirements

A. Foundation seed

A seed crop of Titaly matar shall not be eligible for certification if planted on land on which the same kind of crop was grown within the previous three crop seasons.

B. Certified seed

Land to be used for seed production of *Titaly matar* shall be free of volunteer plants.

III. Field Inspection

A minimum of two inspections shall be made, the first before flowering, the second at flowering and fruit stage.

IV. Field Standards (based on the nearest crop)

A. General requirements

1. Isolation

Titaly matar fields shall be isolated from the contaminants shown in column 1 of the Table below by the distances specified in column 2 and 3 of the said Table.

Contaminants	Minimum distance (meters)	
	Foundation	Certified
Fields of other varieties of the same spp.	10	5
Flower of different colour	10	5
Fields of the same variety not conforming to varietal purity requirements for certification	10	5

B. Specific requirements

Factor	Maximum permitted (%)*	
	Foundation	Certified
Off-types	0.10	0.20

*Maximum permitted at and after flowering.

V. Seed Standards

Factor	Standards for each class	
	Foundation	Certified
Pure seed (minimum)	98.0%	98.0%
Inert matter (maximum)	2.0%	2.0%
Other crop seeds (maximum)	None	10/kg
Weed seeds (maximum)	None	10/kg
Germination (minimum)	80%	80%
Moisture (maximum)	10.0%	10.0%
For vapour-proof containers (maximum)	8.0%	8.0%

*including hard seeds

Proposed Seed Standards of *Stylosanthes hamata*

The standards are proposed based on the frequency analysis of the samples collected from different *Stylosanthes hamata* growing areas of India.

I. Application and Amplification of General Seed Certification Standards

The General Seed Certification Standards are basic and, together with the following specific standards, constitute the standards for certification of the seeds of *Stylosanthes hamata*.

II. Land Requirements

A. Foundation seed

A seed crop of *Stylosanthes hamata* shall not be eligible for certification if planted on land on which the same kind of crop was grown within the previous three crop seasons.

B. Certified seed

Land to be used for seed production of *Stylosanthes hamata* shall be free of volunteer plants.

III. Field Inspection

A minimum of two inspections shall be made, the first before flowering, the second at flowering and fruit stage.

IV. Field standards

A. General requirements

1. Isolation

Seed fields shall be isolated from the contaminants shown in column 1 of the table below by the distances specified in column 2 and 3 of the said table.

Contaminants	Minimum distance (meters)	
	Foundation	Certified
Fields of other varieties of the same spp.	50	25
Fields of the same variety not conforming to varietal purity requirements for certification	50	25

B. Specific requirements

Factor	Maximum permitted (%)*	
	Foundation	Certified
Off-types	0.10	1.0

*Maximum permitted at and after flowering.

V. Seed Standards

Factor	Standards for each class	
	Foundation	Certified
Pure seed (minimum)	75.0%	75.0%
Inert matter (maximum)	25.0%	25.0%
Other crop seeds (maximum)	10/kg	20/kg
Weed seeds (maximum)	10/kg	20/kg
Other Distinguishable varieties (maximum)	10/ kg	20/kg
Germination (minimum)	35%	35%
Moisture (maximum)	10.0%	10.0%
For vapour-proof containers (maximum)	8.0%	8.0%

*including hard seeds

Proposed Seed Standards of *Desmanthus virgatus*

The standards are proposed for the firs time based on the frequency analysis of the samples collected from different *Desmanthus virgatus* growing areas of India.

I. Application and Amplification of General Seed Certification Standards

The General Seed Certification Standards are basic and, together with the following specific standards, constitute the standards for certification of the seeds of *Desmanthus virgatus*.

II. Land Requirements

A. *Foundation seed*

A seed crop of *Desmanthus virgatus* shall not be eligible for certification if planted on land on which the same kind of crop was grown within the previous three crop seasons.

B. *Certified seed*

Land to be used for seed production of *Desmanthus virgatus* shall be free of volunteer plants.

III. Field Inspection

A minimum of two inspections shall be made, the first before flowering, the second at flowering and fruit stage.

IV. Field standards (based on the nearest crop)

A. General requirements

1. Isolation

Desmanthus virgatus seed fields shall be isolated from the contaminants shown in column 1 of the table below by the distances specified in column 2 and 3 of the said table.

Contaminants	Minimum distance (meters)	
	Foundation	Certified
Fields of other varieties of the same spp.	10	5
Fields of the same variety not conforming to varietal purity requirements for certification	10	5

B. Specific requirements

Factor	Maximum permitted (%)*	
	Foundation	Certified
Off-types	0.10	0.20

*Maximum permitted at and after flowering.

V. Seed Standards

Factor	Standards for each class	
	Foundation	Certified
Pure seed (minimum)	98.0%	98.0%
Inert matter (maximum)	2.0%	2.0%
Other crop seeds (maximum)	10/kg	20/kg
Weed seeds (maximum)	5/kg	10/kg
Germination*(minimum)	98%	98%
Moisture (maximum)	9.0%	9.0%
For vapour-proof containers (maximum)	8.0%	8.0%

*including hard seeds

Swachh Bharat Abhiyan

स्वच्छ भारत

एक कदम स्वच्छता की ओर

भाकृअनुप
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