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KERALA KARSHAKAN

English journal

The First English farm journal from the house of Kerala Karshakan

Medicinal Values of

Asoka Tree

INSIDE KERALA KARSHAKAN

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MAY 2024 Volume - 11 Issue - 11

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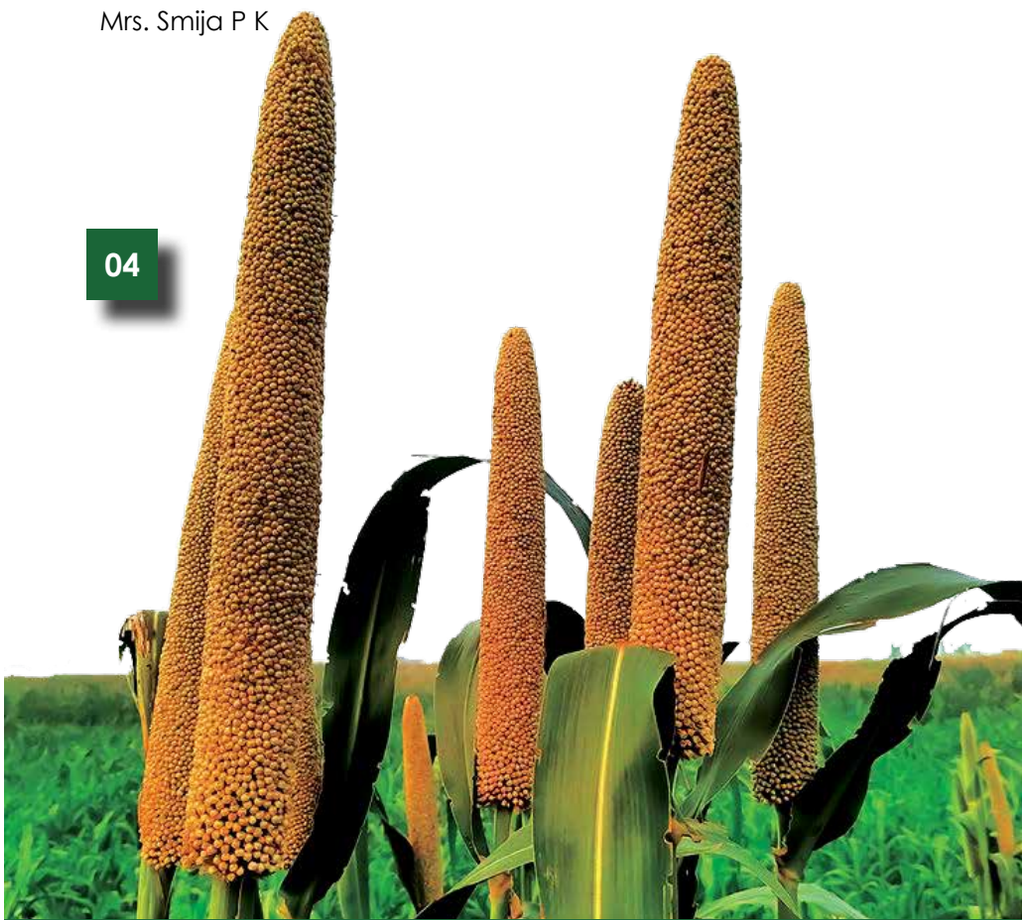

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Abstract

The cultivation of millets as a sustainable and nourishing substitute for conventional grains in dietary habits. The nutritional advantages of millets, their environmental implications and the cultural importance of reintegrating them into contemporary eating habits. The crops of the future because they are good to farmers, consumers, planet and business. Itexplores the hurdles in packages of practices of cultivation, processing and prospects linked with embracing a millet-centric diet, emphasizing its potential in enhancing food security and safeguarding biodiversity.

Introduction

Smallseeded annual cereal grasses represent some of the earliest crops to be domesticated. Rich in nutritional profile with high dietary fibre, proteins and minerals like iron, calcium and

Miracle millets

Crops of the future

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Sorghum

Finger millet

List of millet crops

Common name	Botanical name	Vernacular name
Sorghum	*Sorghum bicolor*	Cholam/Jowar
Pearl millet	*Pennisetum glaucum*	Cumbu
Finger millet	*Eleusine coracana*	Ragi
Foxtail millet	*Setaria italica*	Tenai
Kodo millet	*Paspalum scrobiculatum*	Varagu
Proso millet	*Panicum miliaceum*	Panivaragu
Barnyard millet	*Echinochola frumentacea*	Kudiraivali
Little millet	*Panicum sumatrense*	Samai

zinc. It is grown in over 131 countries and is a staple meal for approximately 60 crore people in Asia and Africa. India produces the most millet in the world.It makes up 20% of global production and 80% of Asian production. Climate-resilient crops exhibit adaptability to diverse ecological conditions, requiring minimal water and inputs to thrive. Millets are widely recognized as superior nutritional content compared to rice and wheat. They contain health-promoting phytochemicals such as polyphenols, lignans, phytosterols, phytoestrogens and phytocyanins, which serve various functions including antioxidative, immune-modulating and detoxifying properties (Dayakar Rao et al., 2018). Moreover, being gluten-free, millets are safe for individuals with gluten allergies and celiac disease. Millet-based diets are also non-

Foxtail millet

acidic, easily digestible and non-allergenic, offering additional health benefits (Saleh et al., 2013). Excellent dietary choice for diabetics due to their high fiber content, low carbohydrate levels and low glycemic index. Sorghum and millets provide enormous industrialization prospects, serving as critical raw materials for the manufacturing of drinkable alcohol and starch (Ganapathy, 2021).

Climatic requirement

Requires warm and moderately humid climate for germination, The sustainable temperature for millet growth is 20-35°C, Minor millets require below 35cm of rainfall, while a few other major millets require at least 40cm of rainfall for a good harvest.

Soil

Generally grown on soils with limited fertility, grown on a variety of soils, from loamy sand alluvial soils to clayey black cotton soils, Medium, red, loamy and shallow soils with good drainage are considered the best, Gravely and stony soils with inadequate fertility are unsuitable.

Field preparation

For optimum germination and crop establishment, use medium to fine tilth, to prepare a good seed bed, the land should be ploughed once or twice and then 3 to 4 times using cross harrows, some locations use a ridge and furrow planting strategy to reduce excess moisture/ water logging, In the case of red, loamy, or shallow soils, add 5-10 tons of FYM per hectare.

Suitable Varieties/Hybrids

Select suitable varieties/hybrids for higher productivity.

Method of sowing

Broadcasting, Line sowing,

Pearl millet

Transplanting, Ridge and Furrow, Broad-bed and furrow system, the seed should be sown at 2.5 cm – 3 cm depth.

Time of sowing

Kharif- First fortnight of July with the onset of monsoon, Rabi- September to October, Summer – January-February.

Seed rate

The recommended seed rate to achieve the required plant population of ~1.5 to 2.0 lakh/ ha for most of the millets is 8.0 to 10.0 kg ha-1.

Spacing

Optimum spacing depends on the type of crop and season. The recommended spacing for various millets is Row to row: 20-30 cm, Between ridges: 45-60 cm, Plant to Plant: 10-15 cm.

Nutrient management

Millets responds well to fertilizer application especially to N and P, Apply Compost or farmyard manure @ 8-10 tonnes/ ha, Soil test-based fertilizers application is recommended, RDF (N, P2O5, K2O kg ha-1):Vary based on soil and water availability, In General: Major Millets: 80:40:40 kg/ha and small millets: 20:20:0 kg/ha.

Inter-cultivation and weed control

Application of one pre-emergence spray followed by hand weeding at 20-25 DAS, effectively control the initial flush of weeds, Inter□cultivation/ hand hoeing 2 or 3 times at 3,

Kodo millet

Proso millet

5 and 7 weeks after sowing to check the weed growth, also helps conserve soil moisture by providing top soil mulch.

Irrigation

Based on the availability of water, one life saving irrigation and 3 to 4 irrigations at critical stages growth i.e. tillering, flowering and grain developmental stage needs to be given.

Millet based intercropping Systems

Millets– compatible for mixed/ intercropping because of their short duration and low input requirement.Intercropping millets with pulses/legumes resulted in 26% higher millet equivalent yield compared to sole crop yield.

Millets+Black gram/ green gram/cow pea
Millets + Sesamum/soybean
Millets + pigeon pea
Millets + Cotton
Millets + Millet

Diseases and Pests

Millets are prone to various diseases and pests.Pests such as seedling pests, stem borers, foliage insects, sucking pests, panicle pests and soil dwellers. Various pathogens, including fungi, bacteria and viruses cause diseases in millets, leading to symptoms such as leaf spots, blights, rots and wilting. Among the most prevalent diseases are blast disease, foot rot and banded/sheath blight, each caused by specific pathogens such as *Pyricularia oryzae, Sclerotium rolfsii and Rhizoctonia solani,* respectively. Continued research efforts are needed to develop new disease and pest resistant millet varieties, improve disease and pests' diagnostics and identify sustainable disease and pests' management strategies.

Harvesting

Harvest is done once the ear-heads are physiologically mature. The crop is ready for harvest in 70-120 days after sowing based on the variety.

Advantages of millets

Climate resilient crops, millets have all kinds of nutrients which improves health and prevents diseases like depression, anxious mood and insomnia, grows in marginal soils with low fertility, provides good quality fodder,

grains with slow releasing carbohydrate, grains can be used as poultry feed.

Constraints in millets Cultivation

Millets were previously grown on 35 million hectares of land. However, it is currently farmed on only 15 million hectares. Low yields,time-consuming and difficult duties in millet processing, which are performed by women, are among the causes of the shift in land use. Millets have a low productivity, Lack of awareness, limited availability, some people feel millets have a bland or disagreeable flavor, which makes them avoid eating them.

Conclusion

Embracing millets is a comprehensive approach to boosting nutrition, which needs climatic requirement, soil, field preparation, suitable varieties, modes of sowing, time of sowing, seed rates, spacing, nutrient management, intercultivation, irrigation,harvesting, advantages, constraints, value additions of millets, government initiatives, promoting environmental sustainability and maintaining cultural heritage. Resilient and equitable food system that benefits both people and the environment by adding millets to our diets as an indigenous food.The contribution of millets to nutrition, livelihood and earnings can play a major role in achieving food security and eradication of poverty. Millets, with their inherent nutritional superiority and unrealized grain output potential, are excellent prospects for future food crops.

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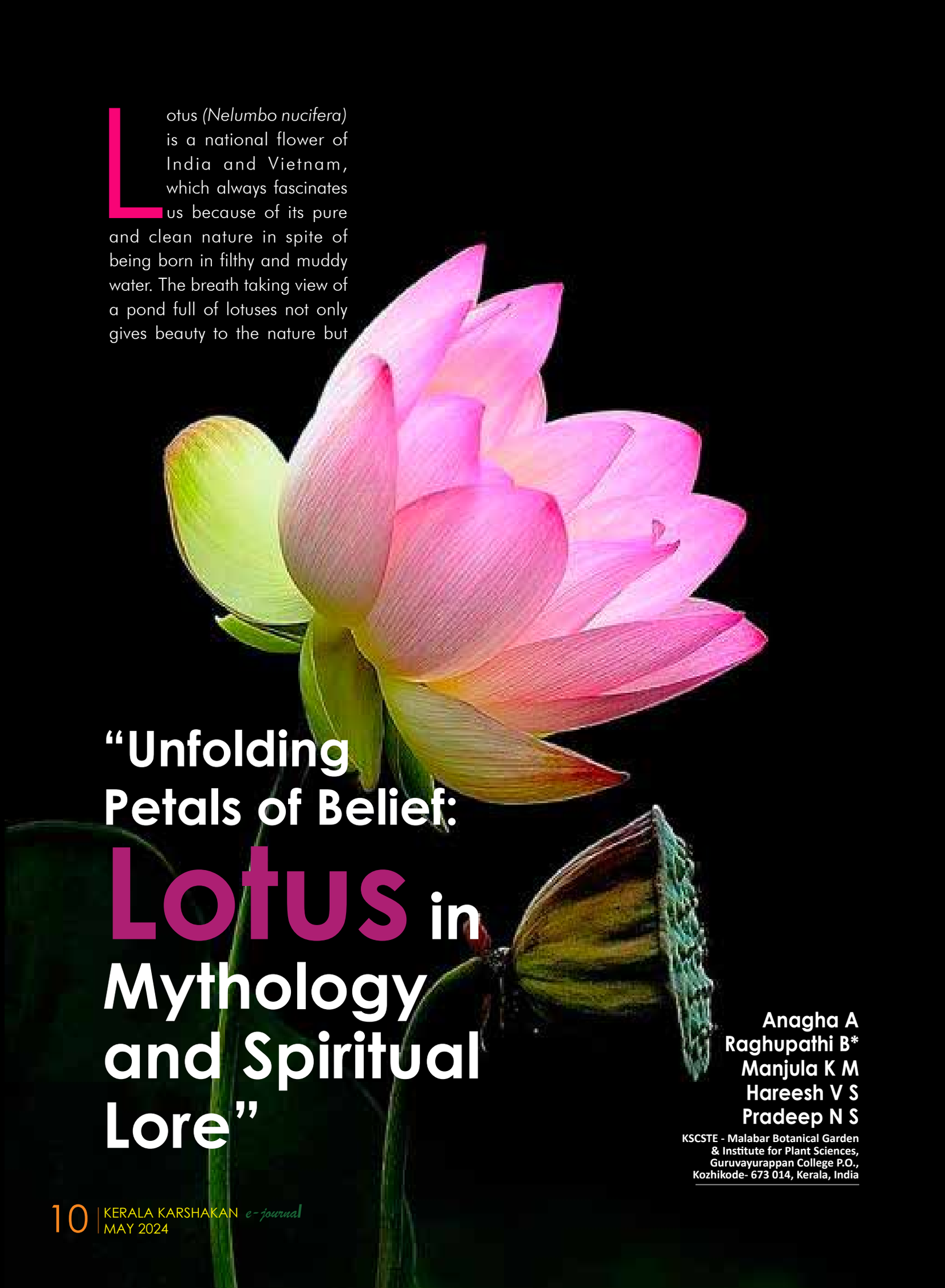
Barnyard millet

Lotus *(Nelumbo nucifera)* is a national flower of India and Vietnam, which always fascinates us because of its pure and clean nature in spite of being born in filthy and muddy water. The breath taking view of a pond full of lotuses not only gives beauty to the nature but



"Unfolding Petals of Belief: Lotus in Mythology and Spiritual Lore"

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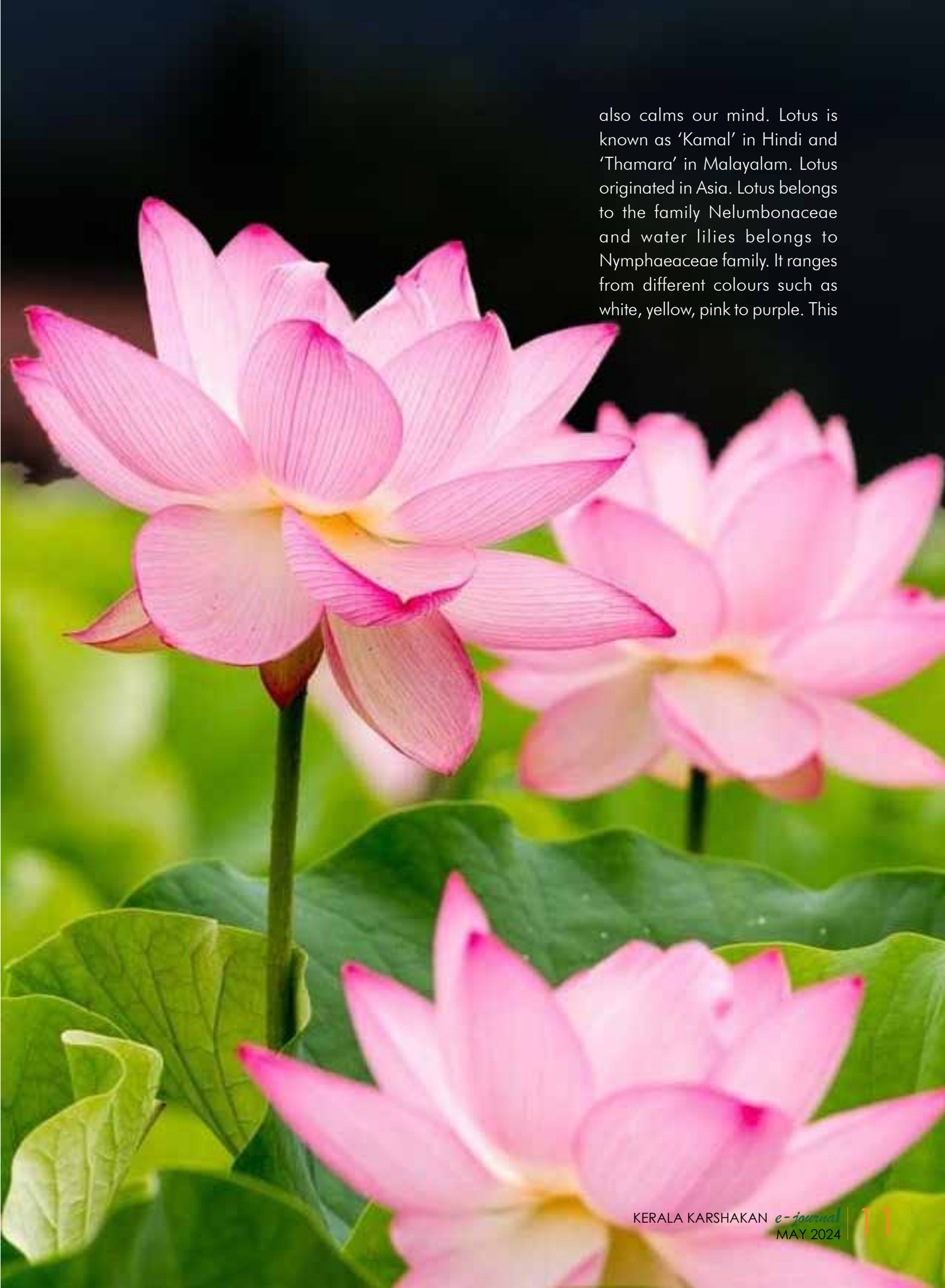

also calms our mind. Lotus is known as 'Kamal' in Hindi and 'Thamara' in Malayalam. Lotus originated in Asia. Lotus belongs to the family Nelumbonaceae and water lilies belongs to Nymphaeaceae family. It ranges from different colours such as white, yellow, pink to purple. This

aquatic perennial has a unique nature which entices every human, thus being described in different poems and songs especially in Asian culture. Lotus has been associated with female beauty, especially a notable usage is “lotus eyes” to describe the eyes of a woman. The flower has abundant significance in different cultures. The name “Lotus” comes from Latin and Greek literature in which they used the word “lotos”to refer to different group of plants. Egyptian water lilies were referred to as lotus in the ancient era. Each and every feature of lotus is remarkable.The super hydrophobic surface of lotus leaf repels water content from its surface to keep it clean. This is a study which led to synthesis of artificial superhydrophobic surfaces. Lotus flower is considered as a sacred symbol across different traditions and countries. Many ancient architectural designs comprise of lotus flower motifs or the leaves and petal designs.It clearly exposes the importance of lotus around the world even though thousands of other species of flowersexist. This article will focus on theimportance of lotus, historyand itsillustrations in cultures and mythologies.

Uses

Apart from its beauty, there are numerous benefits oflotus and its plant parts.Its seeds are so familiar to us as nuts which carries medicinal




properties and are sold in markets.The leaves of lotus plant are used to serve food in different regions of Asia including India. This practice is an ecofriendly measure just like the use of banana leaves in many parts of the world. Lotus flowers are in high demand in market because of its ornamental, medicinal and cultural importance.The edible rhizomes of lotus are used by many people. Lotus roots are sun dried and used as a cuisine in Kerala. It is fried in oil or used to prepare curry. Additionally, plant parts of lotus are used to make tea. This infusion is said to carry several benefits such as stress reduction and digestion. It is a popular tea of Vietnam. Lotus flowers are regularly used as an offering in temples and are used for making garlands for auspicious occasions. Garlands made of lotus are used to worship Gods; it is also used in marriage ceremonies. Lotus silk is another commodity made from lotus by extracting the fiber from the stem manually by hand. It is a tedious process hence produced in a small scale in India and fetches high price. The ability of lotus for phytoremediation is a significant feature. The strong ability of lotus for phytoremediation helps to remove toxic substance such as lead from water bodies.

Symbolism of Lotus across Cultures

Lotus exerts an influence on history of different cultures. It carries various illustrations according to the type of culture and religions. Lotus is most popularly used as a symbol of purity in many cultures. Apparently, this is due to the growth of the flower in murky environment. Despite being born in dirty water, lotus flower tends to amaze by growing above the water without carrying any blemish or stain. It also represents rebirth and strength due the growth of lotus above dirty conditions. Lotus flower opens in the day time and vanishes to the water at night and after few days it withers like any other flower. But due to the perennial nature of the plant many flowers are born for several years which certainly indicates strength and perseverance.Sun and lotus are often associated to each other in mythologies as well in poems. The opening and closing of Lotus are according rise and setting of the sun. When the beam of sunlight hits in the morning, lotus flower blooms and opens all of its petals. This is certainly due to its phototropic nature like any other flower. But back in ancient times, the Egyptians hieroglyphs had mentions of lotus which represented eternal life and rebirth.In archaic times, Egyptians believed in reincarnation. As a result, they painted the tomb with pictures of lotus which was used as a symbol of rebirth.

In the Sikh culture, a religion originated in Punjab, India depicts lotus as a figure

of human soul and spiritual journey. There have been many references of lotus in their manuscripts written by Sikh Gurus. Gurudwaras are places for Sikhs for worshiping their God. The infrastructure of many Gurud war as have dome shape in the form of inverted lotus. One of the popular architectures is of the Golden Temple, in Amritsar where the temple consists of a huge dome on its top in the shape of inverted lotus petals made with marble and plating of gold. Furthermore, motifs of lotus petals are a common pattern in most of Sikh temples. In addition to this, people believe each colored lotus carries different meanings. Feng shui culture which is followed by many people has a symbolization of lotus. Lotus in feng shui indicates beauty and wealth; fortune in family, relationships as well as in business. This Chinese culture is popular because many people believe about the positive energy and luck brought by feng shui in their life. Besides its cultural significance, China holds the first place in production and consumption of lotus around the world.

Buddhism is a religion followed around the word even though it was originated in Ancient India during 5th century. Several symbolisms of lotus flower exist in Buddhist culture relating to its philosophy andSiddartha Gautama,whose preachings are followed in Buddhism. In Buddhist culture, lotus symbolizes the purity and enlightenment of body and soul. It also represents detachment and awakening by suffering all the challenges, because the flower is seen above water uninfluenced by muddy water. A belief such as Gautama Buddha's first seven steps made lotus flower appear, also exists. Many statues of Gautama Buddha are illustrated as Buddha sitting on a lotus flower. In Jainism, which is another ancient religion of India and still an important part of Indian culture, lotus flower is considered as a spiritual symbol.The superior spiritual teachersof this religion are called Tirthankaras. Tirthankaras are depicted as seated on lotus flower. In Jainism, there is a concept of 14 auspicious dreams which were seen by mothers before the birth of their child. One of the dreams, seen by Trishala Mata, mother of LordMahavirbefore his birth included a lake full of lotus flowerswhich symbolized her son would be powerful and brave. Japanese culture too depicts lotus as a notable symbol of purity and

rejuvenation. Therefore,many historically important places, parks and temples have huge varieties of lotus in ponds.In summer season, this view of lotus bloomed ponds is a main attraction. Lotus Sutra is one of the distinguished texts related to Buddhist philosophy. This recounts how people can deal with the challenges in their life, how Buddhahood is attainedand other countless teachings. Since Buddhism is one of the popular religions in Japan, lotus is of utmost importance.

Yoga, discovered before thousands of years in India, practised by many people around the world, is a spiritual pursuit for harmony of one's mind and body. A popular asana in yoga called "Padmasana" or "the lotus pose" is a key meditation posture that provides many benefits to our body. This asana done in seated position with the arrangement of hands, legs and body resembles that of a lotus flower. The thousand petal lotus is regarded as a sacred symbol in philosophy of yoga because a chakra called Sahasrara which means thousand petal is represented by this lotus flower. This particular chakra is said to control our mind by eliminating physical imbalance of our body and mental tensions.

Depictions of Lotus in Hindu Mythology

According to Vedas, which are the oldest scriptures of Hindu literature, there has been descriptions about different Gods of Hindus. Rigveda, one of the Vedas,is dedicated to God and goddesses. We all might have noticed God or Goddess sitting on a lotus flower, referred to as lotus throne. In Hindu mythology, Vishnu,Brahma, Lakshmi, Parvathy, Saraswati and Kubera have been associated with lotus flower. A lotus flower was believed to have emanated from navel of Vishnu, who is known as the God of Preservation. Thus, in many of the sculptures, paintings and arts, Lord Vishnu is represented by carrying a lotus in the hand or standing on the flower. Brahma, the God of creation, is presumed to have been born from the lotus flower emanated from Vishnu. So, Vishnu is known as "Padmanabha" meaning one with lotus navel. It is told that Vishnu advised Brahma to create the universe and remaining creations.

Three major female deities of Hinduism include Saraswati, Lakshmi and Parvati. All three goddesses are illustrated with lotus in paintings and sculptures. Goddess Saraswati is the Goddess of knowledge, art, music and wisdom. She is depicted as wearing a white saree sitting on a lotus flower. It is represented as a symbol of divinity and purity. Moreover, she is considered as the pre - eminent Goddess in Hindu

culture. Lakshmi known as the Goddess of wealth, fortune and prosperity is portrayed wearing red, holding lotus in two hands and seated on a lotus. It represents that irrespective of desirable or difficult situations, positivity and prosperity will prevail. Since Lakshmi is also associated with fertility, lotus is shown as a symbol of woman. Parvathy and lotus flower are often associated representing as a figure of stability, harmony and growth. Kubera, the God of wealth, is characterized to have countenance of a lotus leaf in Hindu traditions. Kubera is illustrated as a stout andpotbellied, carrying amoney bag in his hand.

In Ramayana, an epic Hindu literature, Rama, an avatar of Vishnu and Durga Devi who is a manifestation of Goddess Parvati is linked to a tale of lotus. When Rama has to go to Lanka to kill Ravana who seized his wife Sita, prior to his departure he needs to seek blessings from Durga. For Durga Devi's blessing, he needs to please her by offering 108 lotus flowers. However, he could only acquire 107 lotuses. To worship Durga, he plucked one of his eyes since it resembles lotus petals. Durga was gratified by this act of Rama and blessed him in all sincerity. This comes to relevance during the festival of Navaratri. As a part of Durga puja rituals, lotus flowers are offered to Durga Devi in India.

Another tale from Hindu mythology, explains how Vishnu obtained Sudarshana Chakra by worshipping Lord Shiva with lotus flowers. Vishnu had to go for a battle to defeat the asuras. Before going for the battle, he had to ask help from Shiva. When Vishnu went to Kailash to seek blessings, Shiva was in deep meditation. Vishnu then decided to wake up Shiva through his devotion since he knew that interrupting Shiva's meditation will only cause a havoc. So, Vishnu chooses to offer 1008 lotus flowers but could find one less than this number after searching everywhere. At that moment, Vishnu decides offers Shiva one of his eyes along with the lotus flowers without knowing this was a test by Lord Shiva. Shiva was touched after witnessing this kind act by Vishnu and presented his Sudarshana Chakra to Vishnu.

Tales linked to Lotus from different Cultures

In Greek mythology, the poem The Odessey written by magnificent author Homer describes about lotus. Although lotus has a different meaning in his poem where he describes about an Island of Lotus eaters. In the poem, the staple food for people of this island was lotus fruits and flowers. This plant was said to have narcotic properties which made the men hallucinate and sleep without being concerned about anything around them. King Odysseus and his fellows had to halt and get down in this island while returning to Ithaca after Trojan war. Three of his sailor men were send to see what happens in this island. These men entered in a state of trance after consuming this hallucinogenic plant. The term "lotus-eater" in Homer's poem is metaphor which unveils the human psychology of being enslaved due to luxury and ecstasy. Ancient Egyptians had different myths related to creation of the world. Sun God, referred to as "Ra" was a major deity who they worshipped. It is believed that lotus was borne from water from a mound, and then the lotus flower bloomed to give rise to Sun.

Conclusion

Lotus is a flower which had a great contribution in our history. If we take its physical appearance, its medicinal values or being an eminent part in many philosophies, unlike many other flowers, lotus had made a mark far and wide. Depictions of lotus in cultures asserts the uniqueness of this flower. The information about this flower's depictions in different culture is not closed to this chapter and are distributed among different geographical areas around the world. So next time, when you encounter a lotus pond you will be reminded of different connotations of the flower in different parts of world and among diverse groups of people all united by the unblemished flower.

Medicinal Value of Asoka Tree

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Introduction

Ashoka tree is one among the sacred legendary trees of India. Ashoka, also known as 'Ashok Vriksh' in the common tongue, is quite a well-known indigenous tree that has immense medicinal and spiritual benefits. The word 'Ashoka' signifies 'no grief' in Sanskrit. It is commonly called a tree which is important to decrease your sorrows. This tree has got great religious significance and is also worshipped by some people in parts of India. It is known as 'friend of women' as it is specifically used in the management of raktpradara (menorrhagia) and other female reproductive problems.The bark is

Botanical name

Saraca asoca or Saraca indica
Family: Leguminaceae

Synonyms

Tarapallava, Sita-ashoka, Asupal and Tamarapallava

Regional names

Kannada: Aksunkar, Ashokadamara, Achenge and Kankalimara
Hindi: Ashoka
Tamil: Asogam, Asogm, Sasubam, Asogu and Asokam
Malayalam: Asokam
Marathi: Ashoka, Jasundi
Gujarathi: Asopllaka
Orissa: Ashoka
Kashmiri: Ashok
Bengali: Ashoka
Assamese: Ashoka

A Unopened inflorescence, B Inflorescence, C Immature pod, D Pod development stage, E Matured Green stage pod, F Fully ripened seeds in pod

majorly used, but even other parts of this tree is widely used for different medicinal purposes. It is also remedy for spasms, diabetes, respiratory woes, abdominal pain, skin conditions, kidney problems etc.

Parts used of Ashoka

The parts of the ashoka used in the formation of medicine are-

Ashoka Bark, Ashoka Flowers, Ashoka seeds

Ashoka is a small, erect evergreen tree. grows to a height of about 25-30 feet in height.

Bark: it is smooth with transversely ridged and circular lenticels dark green to greenish grey. Leaves: dark green, alternate, paripinnate compound, stipulate, large and spreading horizontally. Flowers: are fragrant, bisexual, regular flowers with yellowish-orange in hue and apetalous. The tree usually starts blooming from February to April.

Fruits: are pods which are flat, oblong and apiculate with ellipsoid to oblong seeds compressed within them.

Ashoka tree mainly stands apart from the rest of the greenery for its attractive foliage and fragrant flowers.

Geographical Distribution and Habitat of Ashoka

This rainforest tree is native to Asia and South America. In the Indian subcontinent, it is found growing all over India, especially in the Himalayas, West Bengal, Kerala, Andhra Pradesh, Maharashtra and Meghalaya (Khasi, Garo and Lushaj). The Ashoka tree grows quite well in slightly acidic to neutral fertile soils with medium to deep drainage facilities.

Historical and mythological reference of ashoka

In the Indian subcontinent, the sacred Ashoka tree occupies a privileged place in many Indian folk and socio-cultural traditions. In the Buddhist tradition, it is said that Queen Maya of Sakya gave birth to Lord Gautama Buddha under the soothing Ashok Vriksh in a garden in Lumbini, situated in southern Nepal. In Indian epics, the sacred Ramayana too mentioned Ashoka significantly, that Shri Hanumana first met Maa Devi Sita in the Ashoka Vatica (a garden of Ashoka trees) sitting under an Ashok Vriksha, a

Bark of Ashoka plant

place believed to be situated in modern Srilanka.

Chemical constituents of ashoka

Ashoka bark contains tannins, flavonoids, glycoside, saponins, tannins, esters, alkanes and primary alcohols are present in extract. Ashoka leves contains carbhohydrates, tannins, gallic acid and egallic acid,

Ashoka flowers rich in saracasin, saracadin, waxy substance and steroids

Ashoka seeds contain various fatty acids like oleic, linoleic, palmtic and stearic acids.

Medicinal uses of Ashoka plant

It inherently possesses powerful uterotonic, anti-bacterial, anti-implantation, spasmogenic, oxytocic, anti-tumour, anti-progestational, antiestrogenic activity against menorrhagia and anti-cancer properties. Imbued with these properties, Ashoka holds high significance in treating a host of disorders including menstrual disorders, skin infections, liver problems, stomach problems, jaundice, fever, allergy, asthma, indigestion, constipation, diarrhea, rheumatic arthritis, bleeding, diabetes, cardio tonic, diuretic, antipyretic etc. Additionally, it is a successful remedy for treating numerous gynecological problems and hormonal anomalies like menopause, menstrual disorders, dysmenorrheal, amenorrhea, leucorrhoea, and yeast infection.

Remedies Gynecological Anomalies

Deemed as a powerful female-friendly herb, Ashoka is a boon for treating numerous hormonal problems in women. The formulations of Ashoka improve fertility when an individual is trying to conceive. It also plays a key role in regulating periods, treating postnatal health anomalies, and even helping to treat excessive abdominal pain/bleeding. For women suffering from PCOD, intake of Ashoka formulations actively helps in purifying the blood and restores uterus health leading to regular, healthy menstrual cycles. Decoction of the bark was consumed along with water and taken after meals, help treat menstrual problems whereas the powdered formulation is beneficial for treating vaginal infections.

Ashoka uses and Benefits

Ashoka can be used in various forms for different health conditions such as in tablet form, powder form, juice form, decoction form, Capsule form and paste form. It can be used externally according to the condition.

Plant Ayurveda's product which contain this herb as an ingredient

1. Ashoka Powder-it is widely used as a ingredient in the natural supplement for female health.
2. Pradarantak Churna-this herbal powder of ashoka plant is used in the balancing of disturbed female hormones.
3. Female Health Support-this product has its roots in Ayurveda-ancient herbal healthcare system of India. This formulation balances the 3 energies VATA, PITTA and KAPHA in the body is a disease free state whereas their imbalance causes diseases.

Conclusion

Ashoka is a humble female-friendly herb that has immense regenerative and blood-purifying properties. Thanks to the goodness of the essential bio-active components, and the host of medicinal properties, it is extensively used for the treatment and management of a variety of menstrual anomalies, skin conditions, relieving liver problems, managing cough and cold, sore throat, treating respiratory diseases, promoting digestion, healing ulcers and wounds and many more.

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Can FPOs in Kerala evolve into sustainably profit-generating firms?

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Introduction:

The Government of India has been emphasizing growth in real income of the farmers along with an increase in gross production. The "Doubling Farmers' Income Committee" headed by Shri Ashok Dalwai considers Agriculture as a value-led enterprise and suggests empowering farmers with 'improved market linkages' and enabling 'self-sustainable models' as the basis for doubling the real income of farmers. However, in India, nearly 80 percent of farmers cultivate in farms smaller than 2 hectares.

(FAO, 2014). According to the 10th Agricultural Census of Kerala, marginal farmers holding below 1 ha of land accounted for 96.3 percent of the total number of holdings, with the average size of land holding being 0.18 hectares. Kerala is divided into three physiographic regions namely the low land, mid land and the high land; in each region, farmers grow crops specifically suited to the agro climate of the respective region. Thus, the state exhibits a wide range in the crops cultivated by its farmers.

The farmers in Kerala, similar to the farmers in India, have less access to factor markets – for farm credit, technology, inputs of the right quality, agricultural machinery,farm extension services, and farm insurance. Empirical studies indicate that lower economies of scale and lower risk tolerance substantially reduce the farmers' real income. If the farmers can be aggregated under a governance structure, such as in a farmer-owned and farmer run organization, the above-mentioned challenges could be addressed. This thought process led to the establishment of Farmer Producer Companies under section 465 (1) of the Companies Act, 2013. (In this article, the terms FPO and FPC will be used interchangeably). The foundational objective of an FPO is to increase the "Gross Value Added" from the agriculture sector. States of Maharashtra, Uttar Pradesh, Tamil Nadu, Madhya Pradesh, Rajasthan, and Karnataka were the leading states that attempted to organize the farmers under FPOs. Compared to those states, the FPO movement in Kerala is a relatively recent phenomenon and has gathered pace after the devastating floods in Kerala in 2018/ 19 and after the outbreak of COVID-19 in 2020. Today Kerala has 120 FPOs with more than 7000 farmers associated with all the FPOs. Less than a decade (since their inception) is too short a time to evaluate whether the FPOs in Kerala have achieved all their intended establishment objectives. Even then, it is important to take stock of the journey undertaken by selected FPOs, an endeavour resort to next.

Case Study:

To evaluate the progress made by an FPC since its inception, a case study on "Harithodayam FPC' in Karakulam Panchayath, Nedumangad Block, Thiruvananthapuram District was undertaken.Harithodayam FPC was established in the year 2019 and supported by NABARD. The FPC has a group membership of 315 farmers. The major crops grown by the farmers belonging to the FPC are Banana, vegetables and other seasonal fruits. At the time of the establishment of the FPC, the major constraints faced by individual farmers in Karakulam panchayat were:

1. Lack of a marketing network for farmers' products
2. Post-harvest loss due to inadequate post-harvest handling facilities
3. Low income of member farmers.

To address the major challenges outlined, the FPC has implemented a comprehensive management process. Sensing the preference for local produce among peri-urban and urban consumers, the FPC is actively engaged in transferring knowledge on scientific cultivation of major crops in the area to ensure a consistent supply of produce. By establishing transparent financial connections with local production chains and offering a "Safe to Eat" product range, the FPC has significantly enhanced consumer acceptance. Additionally, the FPC suggests small-scale income-generating activities for its members. Leveraging the expertise of Joint Liability Groups (JLGs) on underutilized vegetables and local fruit cultivars, such as Nithyavazhuthana, Breadfruit, leafy vegetables, and Mango cultivar Kottukkonam, the FPC successfully taps into both local and neighboring urban markets, particularly in peri-urban villages like Karakulam.

Following interactions

between farmers and scientists during the "Krishidarshan" program in 2022, the FPC was inspired to initiate small-scale value-addition projects. They collaborated with Dr.Geethalekshmi from the Department of Post-Harvest Technology at the College of Agriculture, Vellayani, to establish a mango ripening chamber. This resulted in uniform ripening of fruits from the local cultivar 'Kottukkonam', ensuring premium pricing due to consistent coloration. In December 2023, they secured approval for a project on dehydrated vegetables, with a financial outlay of 31 lakhs. The management plans to seek technological assistance from the College of Agriculture, Vellayani, and actively seeks knowledge sources on the production of dehydrated vegetables.The FPC seeks expert advice from agricultural scientists residing in the Nedumangad block, particularly those who have demonstrated excellence in their field.

As nodal officer overseeing the operations of the Nedumanagad Block Level Agriculture Knowledge Centre, I was delighted to note that they conduct feacibility studies on new project proposals and translate the insights derived from such studies into tangible and marketable products. They researched the technical aspects involved in the production of "ready-to-maintain" grafted pepper seedlings, collecting field experiences directly from farmers in regions such as Kottayam, Nilambur, and Idukki and launched a collection of 'ready to maintain' plants of Black Pepper, Ginger, Turmeric, and minor fruits for urban homes using appropriate technology.
In response to the surge in ginger rhizome prices in July 2023, reaching from Rs 90 to Rs 220 per kilogram, the FPC met the growing demand by offering portray-based single sprout seed rhizomes and ready-to-maintain ginger plants in grow bags, drawing inspiration from a social media design for "no dig grow bags" originally intended for potato planting.

NABARD officials demonstrate commendable flexibility while staying within the parameters of the promoting organization to support the FPO.

In Kerala, agribusiness firms are recognizing the significance of digital transformation, particularly in the spice tech sector, and are actively seeking venture capital to facilitate this transition. Some companies in the region have already begun implementing such transformations by forming strategic partnerships with venture capital firms. The Digital University, Kerala is designing farmer-centric data governance models to help farmers and FPOs enter into high-value markets. Agribusiness enabler "Samunnathi' has launched its digital platform 'FPOnext.com in August 2023 to digitally connect stakeholders including FPOs with smallholder farmers. The Department of Agriculture and Farmers' Welfare, Kerala has an online marketing platform "Keralagro" launched in April 2023 where FPOs can sell their branded products. Mostof these efforts leverage digital transformation into marketing platforms.

Harithodayam FPO has plans to embrace digital transformation by partnering with prospective startups. This joint effort seeks to create data-driven digital interfaces geared towards assessing production and marketing decision for efficient farm management. These interfaces will be tailored in vernacular language, with minimized data burdens and providing diverse input avenues such as audio and images.

The long-term sustainability of FPOs is closely tied to their integration with agribusiness and technology firms, a process influenced by the market dynamics of the commodities they manage. Equally crucial is the incorporation of invaluable tacit knowledge from informal supply chain and value chain networks into the FPO business ecosystem.

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The Transformative Role of Bioinformatics in Crop Improvement

Introduction

Crop improvement is needed now more than ever with challenges associated with feeding an ever-expanding population under increasingly variable growth conditions. The ability to produce crops that meet societal needs is enhanced by a thorough understanding of the genome of a species. It is crucial for strategic measures to be taken in the field of agriculture. Unfortunately, the slow progress in crop breeding poses a major obstacle to increasing requirement in food production, particularly in low-income nations. Fortunately, with advancements in bioinformatics and the use of omics data, biological and agricultural sciences are being transformed into data-driven disciplines. This evolution presents both opportunities and challenges, laying the groundwork for a discussion on its indispensable role in agriculture and the pressing need for computational resources in agro-informatics to ensure long-term food security. Bioinformatics have pivotal role in crop improvement, shedding light on how breakthroughs in this field are transforming the

landscape of agriculture.

In the pursuit of answers, life scientists are now facing a new challenge: an overwhelming influx of diverse and rapid data. Bioinformatics steps in to decode and make sense of this complexity. Bioinformatics employs computer technology to comprehend and utilize biological and biomedical information. This interdisciplinary field, involving biologists, computer scientists, mathematicians, statisticians and physicists, manages and interprets extensive data from life-science experiments and clinical settings.

Bioinformatics is a crucial field that deals with vital biological information, including DNA sequences, protein structures and different "-omics" streams Each branch of omics, focuses on a specific aspect of molecular biology. Genomics is the study of the entire genome, encompassing all the genes within an organism. Transcriptomics delves into the transcriptome, which comprises all the RNA molecules, including messenger RNA (mRNA), transfer RNA (tRNA) and ribosomal RNA (rRNA), produced in a cell or organism. Proteomics explores the entire set of proteins produced by a cell, tissue, or organism, shedding light on their functions, interactions and modifications. Metabolomics examines the complete set of small-molecule metabolites present in a biological sample, offering insights into the metabolic processes and pathways active in an organism. Additionally, there are other emerging branches like epigenomics, which studies the modifications to DNA and histones that regulate gene expression and microbiomics which investigates the collective genomes of microbial communities.

In order to achieve reliable and repeatable analysis through data integration, a strong partnership between bioinformaticians and experimental biologists is essential. As both data generators and consumers, biologists play a vital part in embracing shared formats and standards to enable seamless integration and facilitate accessibility. Through this collaboration, we can unlock the full potential of biological research and drive significant discoveries. Here we discuss the major areas in which bioinformatics is playing a key role.

Genomic Insights into Crop Improvement

Genomics plays a vital role in unlocking the secrets of crop genetics, uncovering DNA sequences and functional features. By utilizing advanced

sequencing techniques, we can expand our understanding and make significant strides in crop breeding. Through this, we can achieve higher yields, bolster resilience and improve nutritional value in our crops, all of which are paramount for sustaining agriculture in the face of worldwide challenges.

Through the breakthroughs of plant genome sequencing, we now have a deeper understanding of the complicated makeup, evolution and adaptive abilities of plant species. The study of crop genomes has brought to light the occurrence of duplications, rearrangements and polyploidization, unveiling the secrets behind species diversity and functional changes. With the availability of whole genome information of various crops, we are now able to accurately identify transposable elements, gaining new insights into their composition, distribution and evolution. Re-sequencing technology has enabled rapid and efficient genotyping for the identification of single nucleotide polymorphisms and the mapping of haplotypes, supporting the identification of molecular variations and their associations with phenotypes. Conservation genomics has emerged as a powerful tool for unravelling the mysteries of adaptation, genetic drift, natural selection and hybridization, while also aiding in estimating genetic variation and the viability of populations

Utilizing genomic analysis, we are able to precisely identify the genes that play a vital role in producing favourable traits in crops. This method helps us gain a comprehensive understanding of the genetic foundations of desirable characteristics, ultimately allowing us to strategically breed or genetically modify crops for improved performance, higher yields and increased resilience.

Improving Breeding Programs through otechnological innovations

While traditional breeding techniques are certainly effective, they also have their limitations. Not only are they time-consuming and based solely on observable traits, but also face restrictions due to genetic variation. Moreover, the outcomes are often unpredictable and the process is resource-intensive, making it vulnerable to incompatibility barriers and environmental factors. Fortunately, with the advent of modern biotechnological strategies such as genetic engineering and marker-assisted breeding, these challenges can be overcome for improved efficiency and precision in breeding outcomes.

Using a combination of advanced technologies, such as genome sequencing and comparative genomics, bioinformatics speeds up the process of pinpointing desirable traits. Through functional genomics, marker-assisted selection, annotation, pathway analysis, machine learning, database mining and leveraging high-throughput sequencing methods, this field enables the efficient identification of specific genes for targeted breeding purposes in agriculture and other industries.

With the development of molecular techniques, MAS is now used to enhance traditional breeding programs to improve crops and modern plant breeding is dependent on molecular markers for the rapid and precise analysis of germplasm and for trait mapping (Koebner and Summers, 2002). Molecular markers are complementary tools to traditional selection, used to select parental genotypes in breeding programs, eliminate linkage drag in back-crossing and select for traits that are difficult to measure using phenotypic assays. They can increase our understanding of phenotypic characteristics and their genetic association, which may modify the breeding strategy. MAS allows the breeder to achieve early selection of a trait in a breeding program and it is particularly useful when the trait is under complex genetic control, or when phenotypic trials are unreliable or expensive. By increasing favourable allele frequency early in the breeding process, a larger number of small populations can be carried forward in the breeding process, each of which has been pre-screened to remove or reduce the frequency of unfavourable alleles. By identifying genetic markers that are associated with desirable traits, MAS has the potential to greatly improve crop development. However, its impact has been somewhat limited thus far. In order to fully capitalize on its benefits, it is crucial that MAS is integrated into breeding programs and that

any cost barriers are addressed. By tailoring MAS strategies and advancing marker technology, we can make it more accessible, which will in turn promote widespread adoption and lead to the development of even better crop varieties.

Pedigree Analysis

Bioinformatics tools aids in the pedigree analysis process, which is useful for organizing plant breeding programs, particularly when choosing parents for hybridization projects. The study of protein structures aids in the analysis of pedigrees. The field of bioinformatics has emerged as a crucial player in enhancing and revolutionizing the agricultural industry. Through the rapid progression of genomics, including the sequencing of plant and plant pathogen genomes, new avenues have opened up for the genetic enhancement of crops. The abundance of shared traits and expression and function data among diverse plant species has allowed for the discovery of valuable characteristics that can greatly improve crop production. With the completion of genome sequencing for various significant plant species, scientists are now able to identify unique chromosomal and genetic factors that contribute to desirable traits and further advance crop improvement efforts.

Precision Agriculture and Crop Management

Precision farming evolved from the intersection of bioinformatics and agriculture. Farmers may make smarter crop management decisions by integrating data analytics, satellite imaging and sensor technology. Precision agriculture improves resource efficiency, reduces environmental effect and ultimately contributes to sustainable farming practices, from managing irrigation schedules to accurately applying fertilizers. Genomics-Based Precision Agriculture (GBPA) maximizes crop production by taking into account various factors such as soil composition and plant genetics. This personalized approach results in higher yields and promotes environmental sustainability. The success of GBPA is evident in the form of increased crop yields, the potential for decreased fertilizer usage and enhanced food quality. The exciting field of bioinformatics is revolutionizing agriculture, harnessing the power of data-driven technologies to improve crop production and reduce environmental impact. By carefully analysing large datasets, it provides invaluable insight to farmers in choosing the right crop varieties, determining the best time to plant and preventing disease. This revolutionary approach also allows for the precise optimization of fertilizer and water usage, tailoring them to the specific needs of each field. Moreover, bioinformatics contributes to increased crop yields by interpreting genetic patterns, facilitating the development of resilient, nutrient-rich and environmentally sustainable crop varieties.

Tackling Climate Change Challenges

Bioinformatics plays a crucial role in harnessing vast data for climate-resilient crop breeding. Through association studies, it identifies genomic targets for adaptive traits, enabling tailored crops via advanced selection or genome editing. Integration of genomic and phenomic data into accessible databases aids breeders in selecting climate-adaptive traits, addressing challenges in the research and breeding pipeline.

Utilizing bioinformatics approaches, stress tolerance genes are identified through reverse genetics and expression studies. Overexpression and knockout/knockdown analyses in model and crop plants, facilitated by computational methods, reveal candidate gene functions. Despite potential redundancy, these studies offer valuable insights into gene functions, stress responses and applications for enhancing crop stress tolerance through networked response pathways.

Finding ways to use different types of biological data to enhance crop development is a complex task due to the abundance of information involved. Despite being in the early stages of development, these databases show great potential for improving our understanding of biology and advancing breeding methods.

Big Data Challenges and Solutions

The integration of AI and ML in bioinformatics has brought about a revolutionary transformation. By effectively analysing genomic data, predicting intricate protein structures and automating

biomedical image analysis, these technologies have accelerated the pace of drug discovery and enabled us to uncover invaluable insights into functional genomics. Moreover, they have greatly contributed to improving disease diagnosis and facilitating personalized medicine. From text mining to data integration and patient stratification, AI plays a crucial role in providing a comprehensive understanding of biological systems. However, as we embrace these advancements, it is crucial to address issues of data quality and ethical considerations to ensure responsible implementation.

Machine learning for Phenotyping and Transgenic Characteristics

Studying how different molecular elements influence plant phenotypes will be made easier with the use of machine learning in genotype-phenotype prediction. Machine learning has several advantages over classical statistical methods. First, it can identify different kinds of genomic areas. Second, it can anticipate where genomic crossovers will occur, which broadens the field's application in population genetics. Breeders frequently employ quantitative trait loci (QTL) mapping and localization to characterize the underlying genetic architecture of a given trait and clone the causal alleles for research purposes. Plant phenotypic identification has seen successful application of deep learning. In order to examine plant development, a Convolutional Neural Network (CNN) was utilized, for instance, to identify and categorize spikes and spikelets in wheat photos

Biological Databases and its significance in plant research

Biological databases are essential to plant research, because they offer a consolidated store of data on genomics, genetics, taxonomy and other areas of plant biology. Scientists,

Some databases and tools used for data integration and presentation

URL	Purpose	Description
NCBI http://www.ncbi.nlm.nih.gov/	Provides public databases and software tools for analysing biological data, as well as performing research in computational biology.	NCBI) provides a large suite of online resources for biological information and data, including the GenBank® nucleic acid sequence database and the PubMed database of citations and abstracts published in life science journals. The Basic Local Alignment Search Tool (BLAST) finds regions of local similarity between sequences
Uniprot https://www.uniprot.org/	Database and analytical platform for protein sequence and functional information resources	The Uniprot database is the most authoritative source of complete, high-quality, publicly available protein sequence and functional data worldwide
Expasy https://www.expasy.org/	Includes a large selection of software tools and databases for biological research.	The Expasy database is organized into multiple categories, including population, cell, DNA, RNA and protein. It is separated into proteome, genome, transcriptome, structural analysis, population genetics and further more
Galaxy https://usegalaxy.org/	community-driven web-based analysis platform for life science research	Galaxy was originally written for biological data analysis, particularly genomics. The set of available tools has been greatly expanded over the years and Galaxy is now also used for gene expression, genome assembly, proteomics, epigenomics, transcriptomics and host of other disciplines in the life sciences
Tbtools https://bio.tools/tbtools	An integrated toolkit for interactive analysis of big biological data	The toolkit incorporates over 130 functions, which are designed to meet the increasing demand for big-data analyses, ranging from bulk sequence processing to interactive data visualization
ClustalW - MSA https://www.genome.jp/tools-bin/clustalw	General purpose multiple sequence alignment program for DNA or proteins	ClustalW is a tool for aligning multiple protein or nucleotide sequences. The alignment is achieved via three steps: pairwise alignment, guide-tree generation and progressive alignment

URL	Purpose	Description
STRING https://string-db.org/	Biological database and web resource of known and predicted protein–protein interactions.	The STRING database contains information from numerous sources, including experimental data, computational prediction methods and public text collections.
KEGG https://www.genome.jp/kegg/	Collection of databases dealing with genomes, biological pathways, diseases, drugs and chemical substances	KEGG is a database resource for understanding high-level functions and utilities of the biological system, such as the cell, the organism and the ecosystem, from molecular-level information, especially large-scale molecular datasets generated by genome sequencing and other high-throughput experimental technologies

breeders and researchers may access, evaluate and exchange data tthrough these invaluable databases. New advances in sequencing technology have created an endless supply of large amounts of data, all of which are routinely uploaded to specific database. Some of the common bioinformatics databases are listed below:

Through the integration of biological data, computational analysis and cutting-edge technologies, bioinformatics facilitates a more efficient and targeted approach to crop enhancement. With the completion of genome sequencing for various significant plant species, scientists are now able to identify unique chromosomal and genetic factors that contribute to desirable traits and further advance crop improvement efforts

Furthermore, bioinformatics accelerates the process of crop selection, making it possible to develop new varieties with improved yield, resistance to diseases and pests and enhanced nutritional content. This contributes significantly to global food security by increasing agricultural productivity and sustainability. The utilization of bioinformatics tools also promotes the conservation of biodiversity by preserving and utilizing the genetic diversity within crop species.

The interdisciplinary nature of bioinformatics fosters collaboration among biologists, geneticists, agronomists and computer scientists, fostering a holistic approach to crop improvement. As technology continues to advance, bioinformatics will remain at the forefront of agricultural research, providing innovative solutions to the challenges faced by the agricultural industry. Ultimately, the application of bioinformatics in crop improvement not only addresses current agricultural needs but also lays the foundation for a more resilient and productive future in the face of evolving environmental and climatic conditions.

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APPLICATION OF

REMOTE SENSING IN WEED MAPPING

Introduction

Diverse biotic communities are being threatened by invasive alien plant weed species and consequently, cost countries millions to manage. The effective management of these weed species invasions necessitates their frequent and reliable monitoring across broad extent and over a long-term. Hence, introduction and application of a monitoring approach which meet these criteria-based on a three-stage hierarchical classification of identification, mapping and management. So, the concept of remote sensing has been brought into consideration under the sector of agriculture. Remote sensing is the best supporting technique for the identification of the weed species to a large extent of area. It potentially helped as a promising tool for the field of precision weed management. Various tool softwares has been developed for easy monitoring and mapping of invasive weed species.

Why weed mapping is needed?

Weeds hinders navigation and recreation, elevate water losses, cut the

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water flow rates and reduce light penetration into the water body. Hence Chemical Oxygen Demand(COD) and Biological Oxygen Demand(BOD) of aquatic species cannot be met because of floating weeds in aquatic bodies. So weed mapping done to determine its location and so we can go for management measures.

Similarly in case of weed infestation in land mass condition , huge loss of economic yield under agriculture sector was found. Also as weed species sometimes don't cover the entire field, there exists wastage in application of herbicides. Hence precision technology support is much more needed to reduce the input cost of herbicides. So, weed mapping is necessary to easily identify the location of weeds and further going for precise weed management.

The principle of detecting the spatial and temporal variability is being adapted for the study of weed species location by which precision weed management could be done. Regular monitoring of invasive alien weeds is needed to promote targeted, feasible, and effective management. Consequently, there is an urgent need for techniques that enable consistent, frequent, and accurate monitoring of weeds. Remote sensing softwares that can be used:

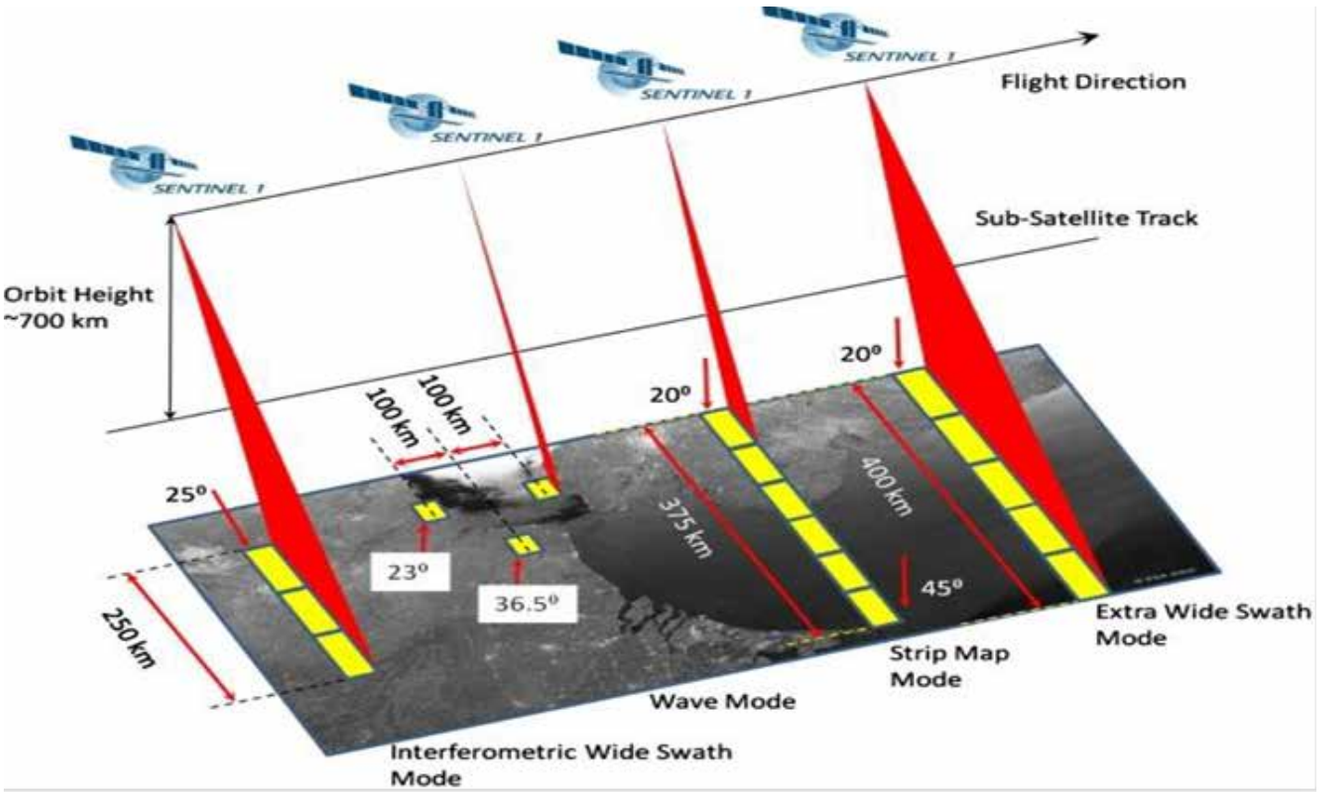
MAPscape RIICE software

This software helps in determining the satellite images interpretation by retrieving the back scattering images obtained by db(decibel) values. Generally there are different types of radiation studies based on Scattering, reflection, and absorption where as here, we are considering the reflected radiation pattern for study purpose.

The radio waves emitted from the satellite once reaches the earth surface, it gets reflected in different pattern formation. For Instance, availability of clouds and dust particles might deviate the reflection pattern and once it reaches the sensor of the satellite, db values are retrieved. By this we can understand the peculiar pattern of radiated reflection for the weed species, through which the weed species distribution can be evaluated. The cost of this software is nearly 13lakhs/ system.

ArcGIS and QGIS

These are free-OPEN Source cross platform softwares. The main purpose of this software is just for the positioning of the water body/land mass location with weed species spread. For



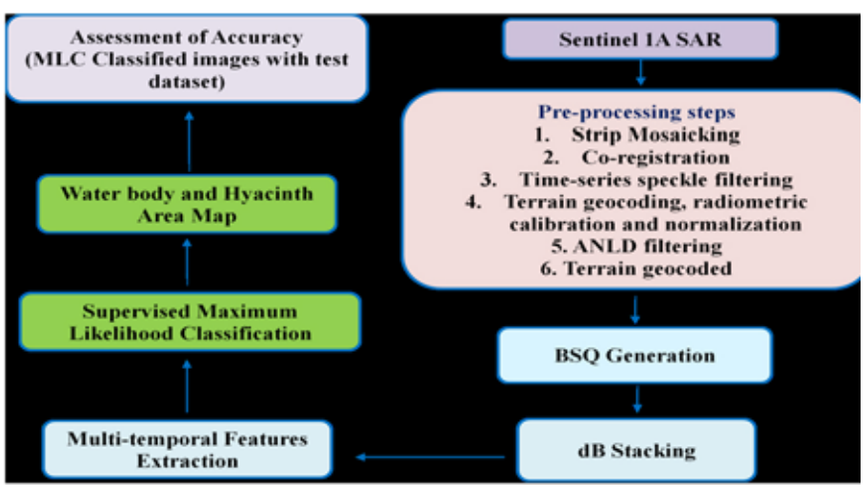
this locating of water bodies, we need to go for manual observation of the respective location to get its latitude and longitude co.ordinates. This helps in the mapping of weed species.

DSSAT

It is one of the crop-cum weed growth simulation model software study. Nearly 42 crop species models are developed under this along with its weed species. With this, the different stages of the weed species could be studied throughout the season from its vegetative to flowering stage. So once we could understand its growing pattern, we can easily alter its source of growth which helps in management of weeds wide-spread.

Copernicus site (easy data collection) for weed mapping:

For easy access of this satellite data, ESA (European Space Agency) has developed an Open access hub called Copernicus site for easy working of weed mapping. Because earlier, to download any data regarding navigation or mapping it was of paid package. But now it is made easier through this open access Copernicus Hub website. And not only water bodies could be studied but also it can used for all aspects like crop area estimation, building sites coverage, Forest area Coverage ,etc.



In this satellite Tracking, Tamilnadu comes under Track number 165 and Track number 92.

The satellite comes around this region every 12 days. So for studying different stages of weed species , we have to overlap every (Sentinal 1A SAR Datas) satellite imagery interpretation for every 12 days(Revisiting period) which gives growth patterns of weed species respectively. By this we can study the 2 Dimensional pattern (Both Temporal and Spatial).

The black and white image in the figure is the raw data image under the satellite . It helps in studying the weed spread. Later, the pre-process and post processing procedures are needed. As the water bodies absorb the radio waves but weeds reflects the radiation based on which the weed mats are detected.

QGIS weed mapping in water bodies:

QGIS is free open source cross platform software used for viewing, editing, printing, analysing of geo-spatial data . It was launched on July 2002. It can be used in multiple Operating systems like Windows, Linux, Mac ,Android. It works on C++ ,Python. It is of Multilingual Language Setup. It is used for mapping the weeds. Also can be used for making out the thematic maps.

STAGE 1 : SURFACE WATER DETECTION

In this, manual observations of waterbodies are taken. This is done by visual observation once reaching that water body spot. The latitudes and longitudes are noted by using the mobile compass. We have to give approximate area coverage estimation of aquatic weed in that water body by visual observation. For example, if half of the water body is covered with weed mats , then we can say that the weed coverage is 50% in that water body.

STAGE 2: QGIS Software mapping

Step 1 : Here three basic operations are considered which includes the polygon, line, points(So called SHAPE FILES). We need to download the navigation map and overlay in the worksheet. And then we need to download the shapefile for our area of interest. Once it is downloaded, it is set as base map for our working purpose.

Step 2: Once the base map for working with area of interest is made, the latitude and longitude co.ordinates that was noted using mobile compass is framed in the BOOK –FEATURE

option. As once it is processed we are able to map the exact location of the water bodies and in peculiar we can identify the weed mats in specific. By this we can finally map the exact location of the water bodies with water hyacinth weed mats and this could be highlighted using point shapfiles respectively.

STAGE 3 : Area Coverage estimation This can be done using GOOGLE EARTH mobile application.

- By using this we can estimate the total weed coverage area in the surface of all the water bodies available in the interested region.
- The MEASURE ICON helps to demarcate the plot border to estimate area of the water body.
- By plotting the area border of all the water bodies, we can easily estimate the total aquatic weed coverage in the interested area.

Merits of weed mapping:

- Sampling theory of statistics works here. Once we get the sample level data in interested region, we can go for population level with wide spread areas. For this, we need to go for remote sensing technology where the data is fed and it helps in seeking similar reflection patterns of weed species over a large area.

Also Time consumption and resource usage is minimised. For instance, if going manual weed survey it is a tedious process. But once weed mapping is done in sample level, it could be taken for population level as

we know a good sample should be a best representor of the population community. By this time consumption is minimized and work is made easier. Quick management support could be done to overcome weed infestation.

Conclusion

Precision with remote sensing softwares make our works easier. So it can be concluded that this weed mapping helps in resource management as it is of sample size working condition. Once the sample working is done, we can go for the population level for large areas which reduces the tedious work and also saves the time. Hence quick management recommendations could be suggested by imagery intepretation. Laborious work is also declined because of software. Since future completely relying on the technology we can also go for Drones technology as once the sample area estimated we can use SNAP software(Free Remote Sensing software) for detecting similar reflection patterns of weeds in population level and easy aerial spray can be done once it is automated,it reduces the laborious work .

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The Harmonising Benefits Of Rosemary

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Rosemary, botanically *Rosmarinus officinalis* L. is a dense evergreen aromatic shrub that belongs to the Lamiaceae family.It is known as 'Gulmehandi' in Hindi. The word 'rosemary' is derived from two Latin words, *'ros'* means 'dew' and *'marinus'* means 'sea' literally, the dew of the sea. In Greek, it is known as *'antos'* meaning 'flower' and symbolises fidelity and remembrance.It is native to the Mediterranean region and is distributed in Spain, Morocco, Tunisia, France, Algeria, and Portugal. In India, it is introduced by the Britishers during the 1960s in the Nilgiris in Tamil Nadu and then distributed to Karnataka, Jammu and Kashmir, Himachal Pradesh, and Uttarakhand. In Tamil Nadu, it is mainly grown in the Ooty, Kodaikanal, Talaivadi, Sathyamangalam, Mettupalyam, and Bergur areas.The branches with leaves and flowers are the economically important parts that produce the superior

essential oil.

It is a dense evergreen perennial aromatic shrub growing 60-200 cm tall. Leaves are non-petiolate with linear or lanceolate shape of variable size in the same branch. The upper leaf surface is dark green, while the underside is whitish due to numerous glandular and non-glandular trichomes that accumulate the volatile oil. Inflorescence is cymose. There are two types of rosemary under cultivation, i.e., Italian rosemary with pale blue or purple coloured flowers and French rosemary with white coloured flowers that yield superior quality essential oil. In India, French rosemary is mainly cultivated. Two varieties, Ooty (RM)-1 and CIM-Hariyali, are released for cultivation in India from TNAU and CSIR-CIMAP, regional station Purara, respectively.

It is propagated through seeds, cuttings and layering. 10-15 cm long cuttings are commercially used as planting material. The nursery stage is required for any propagule. Six to eight weeks old rooted seedlings are transplanted to the main field at a spacing of 45 x 45 cm (50000 seedlings per ha). Intercultural operations like pruning, weeding, fertilizer application, etc., need to be done. The first harvest is done eight months after planting. Subsequent harvests can be done at three to four month intervals. Harvested branches are washed thrice, followed by shade drying.

Essential oil and extraction

The shade dried branches can be used for essential oil extraction. Conventionally, steam and hydro distillation are used for the extraction of essential oil.The high temperature during the extraction process degrades thermoliable compounds, leading to a reduction of extract bioactivity. Moreover, it is time consuming, i.e., it took almost 180 minutes. Therefore, advanced methods like microwave-assisted hydro distillation, supercritical fluid extraction, pressurized liquid extraction, and ultrasound-assisted extraction are followed. The extracted rosemary essential

Dried rosemary leaves

Rosemary-fresh leaves

pasturing in the Mediterranean region, but vegetative pasture availability sometimes becomes scarce. In this background, Smetiet al. (2021) reported that distilled rosemary leaves could partially substitute (about 40 per cent) oat hay requirements of Tunisian local goats without causing any adverse effects on their productivity.

Therapeutic and cosmetic properties of rosemary

Therapeutic properties like anti-stress, anti-depression, memory enhancing, anti-obesity, anti-tumour, anti-inflammatory, anti-bacterial, wound healing, anti-cancer, neuroprotective, and hepatoprotectiveproperties were reported in rosemary. In addition, it has significant cosmetic properties like hair growth promotion, anti-aging, ultraviolet protection and effective acne vulgaris management.Kayashimaet al. (2020) investigated the anti-stress effect of rosemary leaf extract (RLE) in mice. RLE

French Rosemary With White Flowers

and oleoresin valued in recipes, traditional medicine, modern medicine, and aromatherapy, as well as in perfume and flavourindustries.Traditionally, it is used as a culinary herb for seasoning and flavouring meat, sauces and other food products.

Applications of rosemary in food industry

Meat products are highly perishable as they are extensively susceptible to lipid and protein oxidation and microbial growth. Lipid oxidation is a prime deterioration mechanism that produces undesirable flavours and odours, modification in texture, loss of essential fatty acids and creation of undesirable compounds in meat products. The addition of a natural anti- after extraction. The farming community mainly relies on

Ilalian Rosemary With Blue Flowers

oil contains bioactive molecules like monoterpenes, diterpenes, triterpenes, flavonoids, and phenolic acids, contributing to biological properties. In general, monoterpenes contribute to the anti-microbial properties, triterpenes to the anti-inflammatory properties, diterpenes, flavonoids and phenolic acids contribute to the anti-oxidant properties.

The leaves, flowering tops, and twigs yield essential oil

oxidant like rosemary helps in preventing lipid and protein oxidation and microbial growth and thereby enhancing the shelf life of meat products. It can also improve the shelf life of sauces, vegetable oils, mayonnaises, candies, burgers, popcorn, etc. Rosemary extract is a natural anti-oxidant approved by the European Food Safety Authority with a number E392.

Savaniet *al*. (2023) evaluated the anti-oxidant potential of clean rosemary extract (CL) and its effectiveness in replacing ethylene diamine tetra acetic acid (EDTA) in mayonnaise to sustain the product integrity throughout its storage. The anti-oxidant efficacy of EDTA and CL in mayonnaise samples was compared by evaluating their peroxide value, hexanal content, colour value and sensory attributes. 0.19 per cent concentration of CL had better and comparable results with EDTA at 0.0075 per cent.

Applications of rosemary as feed

Rosemary can also be used in animal feed as a dietary supplement or a partial substitute. Rosemary ethanol extract supplementation to the diet of broilers decreased lipid peroxidation and oxidative stress by increasing the antioxidant activity. Rosemary ethanol extract at 200 mg kg-1affected some biochemical parameters positively. Hence, it can be a viable alternative growth promoter in the feeding of broilers (Betulet al., 2018). Dietary supplementation of rosemary extracts improved meat ducks' growth performance and meat quality.

In countries like Tunisia, where they are the major producers of rosemary essential oil, distilled rosemary leaves are a by-product or waste repellent activity. Krzyzowski*et al*. (2020) observed the effectiveness of rosemary essential oil fumigation against cowpea weevil *Callosobruchusmaculatus*,a storage pest. The action of main volatile constituents like 1,8-cineole, camphor, and α-pineneis responsible for the observed repellent activity. Pratiwi and Purwati (2020) reported that the prepared rosemary essential oil gel formulation with a 24 per cent concentration of rosemary essential oil provided 92.15 per cent protection for four hours against the dengue fever causing mosquito *Aedesaegypti*.

Applications of rosemary in nanotechnology

Greensynthesis of nanoparticles is possible using rosemary as the reducing or stabilising agent. So far, iron, magnesium oxide and copper nanoparticles have been synthesised. Rosemary

Hair oil

Rosemary-Tea

iron nanoparticles exert a cytotoxic effect on cancer cell lines. Magnesium oxide nanoparticles synthesised from rosemary were effective against the rice bacterial blight pathogen Xanthomonasoryzaepv. oryzae (Abdallahet al., 2019). Copper nanoparticles synthesised from rosemary were efficient for the tomato grey mold pathogen Botrytis cinerea.

Rosemary-Chicken

Safety and precautions

A low dose of usage or consumption of different formulations of rosemary is safe. However, at high doses, it may cause side effects like vomiting, spasms, pulmonary edema, and even miscarriages. Rosemary supplementation is not advisable for pregnant and lactating women. In the case of pregnant women, it may interact with the foetal cells, causing negative impacts on the foetal cells resulting in miscarriages. It is also not advisable in the case of persons taking prescribed drugs like anti-coagulants, ACE (angiotensin converting enzymes) inhibitors, diuretics and anti-diabetic drugs. ACE inhibitors lower the blood pressure level, whereas rosemary elevates. Both act in the opposite direction, creating a complicated condition.

Available forms of rosemary

Rosemary is available in the market in different forms

Salmon-Rosemary

like fresh rosemary leaves, dried rosemary leaves, oleoresin, extracts, essential oil, etc. Some of the value added products of rosemary include perfumes, rosemary tea, leaf capsules, rosemary water, essential oil, pet supplements, incense sticks, hair care products, etc.

Future prospects

The scope of rosemary cultivation in Kerala has to be exploited through further research as rosemary is not cultivated in Kerala. More varieties suitable for the different agroclimatic conditions have to be released. Under the aroma mission, CSIR-CIMAP promotes the cultivation of emerging aromatic crops like rosemary in India.Rosemary has many biological properties, but all of its mechanism of action is not known, so further studies have to be done. Clinical trials have to be conducted to standardise the doses of usage. Due to its strong anti-oxidant potential, it can serve as an environment friendly food preservative.

Rosemary is an important aromatic shrub with diversified uses in the food industry. It also has significant therapeutic, cosmetic and insect repellent activities. Due to its strong anti-oxidant potential, it can act as a natural anti-oxidant to replace the chemical anti-oxidants currently available in the market. Consumers are increasingly interested in healthier, safer and stable food products without affecting their nutritional and organoleptic profile.

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SUSTAINABLE INTENSIFICATION OF FODDER CROPS THROUGH INTERCROPPING SYSTEMS

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India is gifted with the largest livestock population in the world. There are about 302.34 million bovines (cattle, buffalo), 74.26 million sheep, 148.88 million goats and 9.06 million pigs which accounts 535.78 million as per 20th livestock census in the country (DAHD&F, 2019). Though India is having highest livestock population their production potential not realized fully because of constraints related to feeding, breeding, health and management. At present, the country faces a net deficit of about 30.6 percent green fodder and 11.9 percent dry crop residues because the area under fodder crop is estimated to be 8.4m ha which is only 4.9 percent of total cropped area in India. The cultivated area under fodder crops in Kerala is 5227 ha. The fodder requirement in the state is 232 MT whereas

the availability is only 94.5 MT (ICAR-IGFRI, 2020).Allocation of more land under fodder crop alone is not possible.Hence, the need of the hour is to increase productivity per unit area which can be achieved by modifying the existing cropping systems.

Cropping systems

Cropping system consist of pattern of crops taken up for a given piece of land or order in which the crops are cultivated on a piece of land over a fixed period and their interaction with resources and other farm enterprises and available technology which determine their makeup.The approach to fostering agricultural productivity and sustainability is to increase the diversity of cropping systems, possible through intercropping. Fodder production intercropping system

Fodder production intercropping systems include

1. food fodder production system
2. fodder production under plantations and orchards
3. Intensive fodder production systems

1.Food fodder production system- Maize based system

The lowest maize grain yield was obtained by growing guinea grass and maize simultaneously. The highest corn grain yield was obtained by seeding guinea grass at the same time as corn fertiliser topdressing (25 days after sowing). Guinea grass should therefore only be intercropped with maize during topdressing fertilisation, according to recommendations. Because the timing of intercropping has little impact on production, palisade grass can be planted alongside corn both concurrently and during the topdressing fertilisation stage(Borghi et al., 2013).

2. Fodder production under plantations and orchards

Intercropping of fodder cowpea in the coconut garden can be done either by utilizing the entire inter space for fodder cowpea alone or by using 75 per cent of inter space for fodder grass and 25 per cent inter space for cowpea (Subramanian et al.,

2014).

Shade tolerance potential of six selected cultivars of hybrid napier (Co-3, Co-4, Suguna, IGFRI-3, DHN-6 and PTH) were assessed. Among the cultivars studied, Co-3, Suguna and IGFRI-3 recorded less than 15 per cent yield reduction under 25 per cent shade. Similarly, the cultivars Co-3 and Suguna recorded less than 25 per cent yield reduction under 50 per cent shade, so they can be grown in plantations where the light availability is not less than 50 per cent (Antony and Thomas 2015).

3.Intensive fodder production systems

Fodder sorghum intercropped with fodder cowpea (50 per cent seed rate) had higher green fodder yield, sorghum equivalent yield, net returns and land equivalent ratio, when it was comparable with Intercropping of sorghum with cowpea (25 per cent seed rate) that had higher digestible dry matter yield (Pal et al., 2014).

Fodder pearl millet intercropped with fodder cluster bean

Arif et al.(2022) conducted an experiment on pearl millet and cluster bean intercropping for enhancing fodder productivity, profitability and land use efficiency by using two treatment of sole crop (pearl millet and cluster bean) and seven intercropping combinations of pearl millet and cluster bean. As a result of intercropping at (2:1) row ratio of pearl millet and cluster bean, the highest value of phosphorus and potassium uptake, LER, Monetary Yield Advantage (MAI), net return, and benefit cost ratio were observed.

Sustainability nature of intercropping systems

1. Pest management

Crops grown in intercropping system increase the population of beneficial insects like parasites and predators, which ultimately prevents the dynamics of pest population growth. This lowers the cost of plant protection, reduces the usage of toxic chemicals, and eventually reduces pollution of the agricultural ecosystem. The complexity of an insect's host and environment can simply change with the addition of more species in intercropping.

2. Nutrient management

In comparison to geranium grown alone, intercropping it with fodder crops increased soil organic carbon (SOC) and total kjeldal nitrogen (TKN) by 7.8–69.2% and 10.7-92.8%, respectively. It results in enhancement of soil MBC(microbial biomass carbon) (Verma et al., 2014)

3. Weed management

By utilisation of inter space for other crop weed suppression and also resources use efficiency increases. The intercropping of canary grass with red clover and almond recorded minimum weed density (10.64 m−2) and maximum weed control efficiency (79.85 per cent) compared to control plot (natural vegetation, 90.64m2).(Ahmad et al.,2021)

4. Environmental protection

To evaluate carbon sequestration, grasses like hybrid napier and guinea grass are intercropped with legumes like desmanthus, agathi, and fodder cowpea. Among these BN hybrids (paired row) with fodder cowpea was found as the most promising system for meeting both farmer needs and environmental sustainability (Thomas et al., 2021)

5. Water quality & water conservation

Cereal,legume intercropping systems irrigated with treated grey water caused increase in protein percentage because of increasing in nutrient present in treated grey water is available to this cropping system. Additionally, using treated water helps lessen the already difficult demand for freshwater caused by population growth. (Houshia et al., 2022).

6. Crop diversity

Growing a greater variety of crops on a farm can help reduce risks from extremes in weather, market conditions or crop pests. Increased diversity of crops and other plants, such as trees and shrubs, also can contribute to soil conservation, wildlife habitat and increased

populations of beneficial insects.

Limitation of fodder and intercropping system

- Alleolopathic effect between crops.
- Antinutritional factors
- Due to the negative effects of competition, yield declines.
- Impairs the free use of farm equipment and machinery for a variety of agricultural operations.
- By harbouring insect pests and diseases, it serves as a substitute host for different pests and diseases.
- A barrier to chemical weed control;
- Additional preparation and management efforts are needed.

Conclusion

There is a critical need to satisfy the expanding demand from the livestock population. To increase the production of fodder, it is important to increase biomass per unit area by including fodder crops into the current cropping system. Reorienting the current cropping method will safeguard a boost in herbage production, an enhancement in the calibre of the fodder, and an improvement in farm profit.

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