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Changthangi Sheep:

The pride of Ladakh

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Abstract

Changthangi breed is generally described as *Changthangi* sheep as per the name of its breeding tract. Local farmers of the area called it by Changluk meaning sheep of northern plateau (Chang = Northern, Thang = Plateau / Plain, Luk = Sheep). The breed is reared for quadruple purpose: mutton, wool, manure and dung energy. This breed of sheep sustains the economy of *Changpas* to a greater extent but next only to pashmina goats. Changthang region has harsh climatic dryness with very low rainfall where temperature varies from -40°C to $+40^{\circ}\text{C}$. Almost every household is having 50-100 sheep. The color of the sheep varies from complete black to white and brown. Most of the animals have a mixture of these three colors however the white is predominant. The average wool production is found to be 1.5 to 2 kg and is higher in male than female. Both horned and polled pattern animals are found in *Changthangi* breed and very few are polycerous also. The adult weight of Changthangi sheep ranges from 40-52 kgs in males and 35-42 kgs in females. These are seasonal breeders and breeding season is from July-November while main Lambing season is December to March. The occurrences of the diseases are very less but very few common diseases affecting the *Changthangi* sheep are Diarrhea, Clostridial diseases, Brucellosis, Foot and Mouth disease, Ecthyma and Sheep pox.

Key Words: Changthangi sheep, Chagluk, Changpas, Ladakh

Introduction

For many Changpas, rearing of animals, and consuming and selling their produce (milk and its products, hair and meat) is the only means of livelihood. Changthangi sheep is a multipurpose breed and is utilized for wool, guard hair, pelt, meat, milk production and, dung energy. The breed is having two fleece coats; the outer course and the inner coat, which protects the breed during harsh winters when temperature drops to -40 degrees Celsius. The wool is naturally grown on the sheep to protect it from the cold. At the beginning of summer season, in May and June, the local people comb the wool with the help of a local comb specially designed for this purpose or do shearing. The average wool production is found to be 1.5 to 2 kg and is higher in male than female, out of

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which almost 700-800 grams of ne wool is produced. Almost every household is having 50-100 sheep. The wool is used for weaving of the woollen products. Each family is having sufficient raw wool and they do not need to procure it from any other source. The Changpas also use the pelts as clothing as well as flooring material in their tents, which keeps their tents warm in the freezing temperature. They use the dung of this sheep as a source of fuel energy for cooking of foods and keeping their tent warm. They use milk of this sheep for making of salt tea. Buddhists usually do not slaughter or kill their animal but they do eat their meat whenever animal dies naturally or is killed by some predator.

Distribution and breeding tract

Distribution of native tract in terms of longitude and latitude extends between 32°-3 to 34°-0 North and 77°-5 to 79°-10 East. The geographical area of the breeding tract is about 24,000 squares km. The breeding tract of the Changthangi sheep comprises of various villages located in main and collateral valleys of Changthang area. It includes valleys of Rong, Nyoma, Kuyul (all these three valleys are basin of the river Sindh), and with some collateral valleys, Puga and Rupsu, Kharnakand Tso Kar of Nyoma block of Changthang. The villages of Cheshule, Pangong and Krygam valleys are the remaining portion of the breeding tract and these areas falls in Durbuk block of Changthang. These valleys are mostly of about 30 kms in length and of varying breadth. The breeding tract lies in Leh district. This area falls in cold arid region of western subcontinent between the Korakaram and the Greater Himalayas interwoven with barren and rugged mountains forming some big and small side valleys. On the North-East side of the breeding tract

is the Tibet and China and its southern side is bounded by Chamba and Lahul-Spiti Districts of Himachal Pradesh. The terrain is mostly mountainous and denuded. The Changthang area is divided into two rural developmental blocks- Durbuk and Nyoma. The Changthang is derived from a Tibetan word meaning northern plains (Chang =northern, thang = plains). Whole of the breeding tract was divided into 12 and villages. The elevation of the breeding tract varies from 3,340 to 4,560 m above MSL and these elevations correspond to Liksy and Korzook villages, respectively. The physiography of the area is mountainous with long valleys between them. The animals are reared extensively in the pastures up to 5,200m above MSL.

Physical traits of Changthangi sheep

Colour: The colour ranges from complete black to white and brown. Most of the animals has a mixture of these three colours however the white is predominant.

Horns: Both horned and polled animals are present and very few are polycerous also.

Ears: Both the ears are pendulous.

Wattles: Wattles were observed only in 2% and majority of the animals did not have any wattle.

Head: Atypical convex head with a long tapering face.

Tail: The tail is medium or short. The tail is thin and straight in all the cases.

Udder pattern: The females have medium sized udder with small conical teats.

Legs: Legs are short giving a low-set conformation

Morphometric traits

Body weight(kgs):Adult Male: 40-52, Adult Female:35-42

Body Length (cms): Adult Male:50.02–70.00, Adult Female: 45.00–67.00

Chest Girth (cms): Adult Male: 70-85, Adult Female: 67-78

Height at withers (cms): Adult Male:47-60, Adult Female: 45-55

Ear Length (cms): Adult Male:5.0-7.5, Adult Female: 5.0-7.0

Tail Length (cms): Adult Male:7-8.5, Adult Female: 6.5-8

Reproduction traits

Age at first mating (months): Male 24-30, Female 26-32

Age at first estrus (months): 16-18

Estrus cycle duration (days): 21-22

Estrus duration (hours): 36-48

Age at first lambing (months): 28-30

Lambing interval (months): 12-14

Litter size: 1

Lifetime number of lambs: 6-8

Production traits

Wool traits

Clean wool yield (%): Male: 71.50, Female: 70.00

Fiber diameter (μ): Male: 32.17, Female: 30.18

Staple length (cms): Male 13.90, Female: 12.95

Number of crimps per centimeter: Male: 4.8, Female: 3.98

Medullation %age: Male: 12.85, Female: 10.07

Carcass traits

Age at slaughter (months): Male: 22-32, Female: 30-62

Weight at slaughter (kgs): Male: 25, Female: 24

Carcass weight (kgs): Male: 17.78, Female: 16.50

Dressing percentage: Male: 46, Female: 45

Milk traits: No milk is taken from the sheep; however, the sheep has sufficient milk for their lambs.

Diseases and their management: The occurrences of the diseases in its native tract are very less. Common bacterial diseases affecting the are Diarrhea and Clostridial diseases and occasional incidence of Brucellosis are also reported. The commonly reported viral diseases are Foot and Mouth disease, Ecthyma, Sheep pox. The sheep are sometimes vaccinated against Foot and Mouth disease, Pox and Clostridial disease (Lamb dysentery, Struck, Malignant oedema, Pulpy Kidney, Black's disease). For protection against the Clostridia disease multi-component Clostridial vaccine is administered.



Male



Female



Flock of Changthangi sheep

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Polymerase Chain reaction (PCR) in Life Sciences

DOI: <https://doi.org/10.5281/zenodo.6587393>

Background

The polymerase chain reaction (PCR) is a rapid, inexpensive and simple way of copying specific DNA fragments from minute quantities of source DNA material also called as “PEOPLE’S (P) CHOICE (C) REACTION” (R). It is a revolutionary method developed by Kary Mullis in the 1980s an American biochemist who won the Nobel Prize for Chemistry in 1993 for his invention. Before the development of PCR, the methods used to amplify, or generate copies of, recombinant DNA fragments were time-consuming and labour-intensive. In contrast, a machine designed to carry out PCR reactions can complete many rounds of replication, producing billions of copies of a DNA fragment, in only a few hours. PCR is based on using the ability of DNA polymerase to synthesize new strand of DNA complementary to the offered template strand. Because DNA polymerase can add a nucleotide only onto a pre-existing 3'-OH group, it needs a primer to which it can add the first nucleotide. At the end of the PCR reaction, the specific sequence will be accumulated in billions of copies (amplicons). PCR is now a common and often indispensable technique used in medical laboratory and clinical laboratory research for a broad variety of applications including biomedical research and criminal forensics.

Before PCR is performed, DNA must be isolated from peripheral blood, hair follicles, cheek cells, or tissue samples. Isolated DNA is double stranded, meaning that there are two sequences of letters or nucleotide bases (A or adenine, G or guanine, C or cytosine, and T or thymine). The double stranded DNA is held together by complementary base pairings in that A binds to T, C binds to G makes the complementary strand of the molecule understood. So, TTAACGGGGCCCTTAAA.....TTTAAACCCGGGTTT

Principle

The target sequence of nucleic acid is denatured to single strands, primers specific for each target strand sequence are added, and DNA polymerase catalyzes the addition of deoxynucleotides to extend and produce new strands complementary to each of the target sequence strands (cycle 1). In cycle 2, both double-stranded products of cycle 1 are denatured and subsequently serve as targets for more primer annealing and extension by DNA polymerase. After 25 to 30 cycles, at least 10^7 copies of target DNA may be produced by means of this thermal cycling.

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Mechanism Of PCR

It is important to note that since the new strand extends beyond the target DNA, they will contain a region next to their 3'-end that is complementary to the other prime

- **Step I: Denaturation**

This step is the first regular cycling event and consists of heating the reaction chamber to 94–98 °C (201–208 °F) for 20–30 seconds. This causes DNA melting, or denaturation, of the double-stranded DNA template by breaking the hydrogen bonds between complementary bases, yielding two single-stranded DNA molecules.

- **Step II: Annealing**

In the next step, the reaction temperature is lowered to 50–65 °C (122–149 °F) for 20–40 seconds, allowing annealing of the primers to each of the single-stranded DNA templates. The primers are single-stranded sequences themselves, but are much shorter than the length of the target region, complementing only very short sequences at the 3' end of each strand.

- **Step III Extension/elongation:**

The temperature at this step depends on the DNA polymerase used the optimum activity temperature for the thermostable DNA polymerase of Taq (*Thermus aquaticus*) polymerase is approximately 75–80 °C (167–176 °F) though a temperature of 72 °C (162 °F) is commonly used with this enzyme. In this step, the DNA polymerase synthesizes a new DNA strand complementary to the DNA template strand by adding free dNTPs from the reaction mixture that is complementary to the template in the 5'-to-3' direction, condensing the 5'-phosphate group of the dNTPs with the 3'-hydroxy group at the end of the nascent (elongating) DNA strand. The precise time required for elongation depends both on the DNA

polymerase used and on the length of the DNA target region to amplify. As a rule, at their optimal temperature, most DNA polymerases polymerize a thousand bases per minute. Under optimal conditions at each extension/elongation step, the number of DNA target sequences is doubled. With each successive cycle, the original template strands plus all newly generated strands become template strands for the next round of elongation, leading to exponential (geometric) amplification of the specific DNA target region.

Components Of PCR

The PCR Reaction Components are as follows:

- Mg²⁺
- Water
- Primer
- dNTPs
- PCR Buffer
- DNA polymerase

Plateau effect

The term plateau effect is used to describe the attenuation of the normally exponential rate of product accumulation in PCR. The attenuation occurs during the late PCR cycles when the accumulation of product reaches 0.3 to 1 picomole. Depending on reaction conditions and thermal cycling, one or more of the following may influence when the plateau is reached:

- Depletion of substrates (dNTPs or primers)
- End-product inhibition (pyrophosphate, duplex DNA)
- Competition for reactants by nonspecific products or primer-dimer
- Reannealing of specific product at concentration above 0.8 M (may decrease the extension rate or processivity of Taq DNA polymerase or change branch-migration of product strands and displacement of primers)
- Incomplete denaturation/strand separation of product at high product concentration.

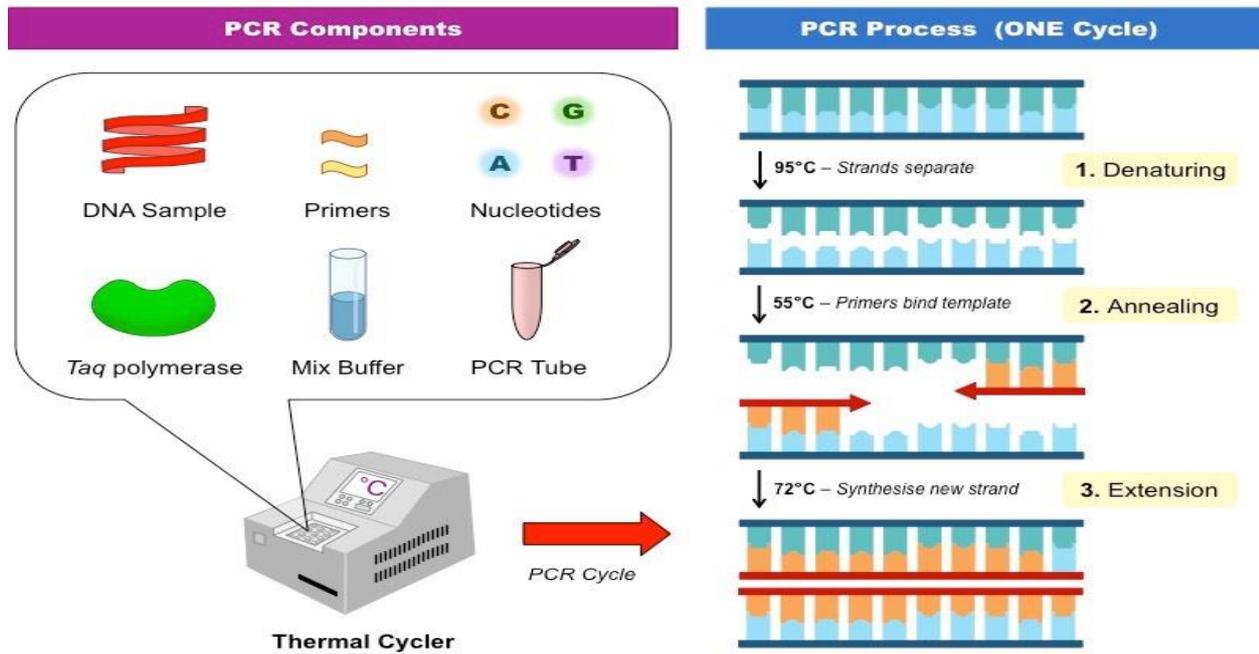


Fig 1: Overview of PCR

Applications

PCR has a broad range of applications, not only in basic research but also in the areas of medical diagnostics, forensics, and agriculture. Some examples of PCR applications include:

- **Genotyping**

PCR can be used to detect sequence variations in alleles in specific cells or organisms. Genotyping by PCR is also a fundamental aspect of genetic analyses of mutations in cancer and heredity. The primer sets are designed to flank regions of interest and assess genetic variations based on the presence or absence of an amplicon and/or its length.

- **PCR cloning**

PCR is widely used in cloning DNA fragments of interest, in a technique known as PCR cloning. In direct PCR cloning, the desired region of a DNA source (e.g., gDNA, cDNA, plasmid DNA) is amplified and inserted into specially designed compatible vectors. Alternatively, primers may be designed with additional nucleotides at their 5' end for further manipulation before insertion.

- **Methylation**

PCR can be employed to investigate locus-specific methylation. In a method called methylation-specific PCR (MSP), two primer pairs are designed to differentiate the methylation state of the locus of interest. Positive PCR amplification resulting from primer binding is used to determine the methylation state of the locus.

- **Mutagenesis**

One of the benefits of PCR cloning is the ability to introduce desired mutations into the gene of interest via cloning, for mutagenesis studies. In site-directed mutagenesis, PCR primers are designed to incorporate base substitutions, deletions, or insertions within a specific sequence. Primers are directed at a sequence that has already been cloned in a plasmid.

- **Sequencing**

PCR is a relatively simple approach for enriching template DNA for sequencing. High-fidelity PCR is highly recommended for preparation of sequencing templates, in order to maintain DNA sequence accuracy.

MERITS OF PCR

- Specific, highly sensitive technique
- Relatively very simple
- Purity of DNA preparation is not critical
- Even degraded DNA can be used
- Highly versatile technique
- Quantity of DNA required for PCR is low.

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Sprouted grains:

A healthy, nutrition-rich diet

DOI: <https://doi.org/10.5281/zenodo.6587438>

Background

Plants are outstanding sources of phenolic phytochemicals out of which the antioxidants have a magnificent role within the therapeutic applications as functional food components. Sprouts are germinated seeds and become the future young plants. The germination process usually initiates with the seeds being soaked for many hours. The soaked seeds are then exposed to the proper combination of temperature and moisture conditions, and allowed to grow for two to seven days. Sprouting may be a process of germination during which seeds or spores put out shoots, plants produce new leaves or buds. Germinating seeds play a crucial role in nutrition that the sprouts to be eaten raw or cooked. Germinated sprouts have been increased the vitamins, minerals, proteins, and enzymes. Sprouting characteristics like sprouting rate give information about the age of seeds. The sprouts are good sources of saccharides, enzymes, amino acids, protein, vitamins, minerals and they also contain important nutrients like glucosinolates, phenolic, flavonoids, isoflavones, and selenium-containing components that are most useful in the respect of human health. The nutrient concentration of sprouts remains very high in the initial growing stage so that sprouts are consumed at this stage. Aging retards the rate of sprouting and affects viability appreciably. From a sensory point of view of seeds sprouting characteristics are also important.

Keywords: Grains, Germination, seeds.

The different varieties of sprouts

Alfalfa Sprouts

In the U.S these sprouts are the most common sprout varieties consumed. The common alfalfa plant is *Medicago sativa*. It is a legume, which in its full form, is usually used as a forage crop for cattle. Counting on the variability of seed, sprouts will germinate and grow approximately 3-7 days after seeds have been placed in a warm, humid environment. These sprouts are a good source of vitamins A and C, iron (Fe), calcium (Ca), protein, and dietary fiber.

Radish Sprouts

Radish sprouts belong Brassicaceae family with the botanical name *Raphanus sativus*. The sprouts are available in many varieties and are edible root vegetables. Its root varies in flavor, size, and length counting on which part of the world.

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They have a spicy bite. Radish sprouts are generally consumed as raw or lightly cooked, found in salads and sushi, or also used as a garnish. They are rich in vitamins B, vitamin C, folate, and manganese.

Green mung

In green mung, the presence of significant amounts of protein, calories, and some water-soluble vitamins in green mung makes a promising food ingredient. The mung bean with botanical name *Vigna radiata* is called *sabut mung* in Hindi. It belongs to the family Poaceae that has been consumed as a common food in China for more than 2,000 years. It is documented for its detoxification activities and is used to refresh mentality, alleviate heat stroke, and reduce swelling in the summer season.

Wheat sprouts

Wheat sprouts are a super healthy food that contains immune-boosting enzymes, cancer-fighting agents, and a host of important vitamins and minerals. It is simply the beginning phase of early sprouted growth of the common wheat plant with scientific name *Triticum aestivum*. It is known to be a rich source of vitamins A, C, and E, and minerals such as calcium, iron, and magnesium, and amino acids and chlorophyll.

Chickpea sprouts

It is also called garbanzo bean or Bengal gram, which is an Old-World pulse. The botanical name is *Cicer arietinum* L. also called as Black chana in Hindi. Chickpea has significant amounts of all the essential amino acids except sulfur-containing amino acids, which can be complemented by adding cereals to the daily diet. chickpea is rich in nutritionally important unsaturated fatty acids like linoleic and oleic acids, the presence of lipids are very less. The important sterols such as β -Sitosterol, campesterol, and stigmasterol are present in chickpea oil. Calcium (Ca), Magnesium (Mg), Phosphorous (P) and especially, K (Potassium) is also present in chickpea seeds. Chickpea or Black chana is a potential source of vitamins such as riboflavin, niacin, thiamin, folate, and therefore the vitamin A precursor β -carotene.

Soybean Sprouts

Soybean is also high in fiber and protein. It is a nice addition to stews and casseroles. It is great for cooking, becomes more of a healthy, Vitamin K is usually overlooked, it plays an important role in regulating the density of bone minerals, Vitamins C and K in soybean sprouts are essential in the process of healing. Improving Heart Health, Reducing stress and anxiety.

Home-grown sprout

Sprouts are a nutrition-rich diet. The lovers of sprouts like to grow their own at home. It is a potential source of nutrition and a plethora of health benefits. Sprouts are delicious, nutritious, and are a breeze to sprout at home. Not only do they taste better than store-bought, but no sprout maker is also needed.

The fresh sprouts home, they should be chilled and stored in a refrigerator, and before and after handling sprouts and rinsing sprouts well before using them. To prevent contamination rinsing off other materials that could be harmful before you consume them. The appearance of sprouts matters, too. If they are slimy, smelly, or musty, you should throw them out right away.

Significance in Daily life

In Eastern countries, the sprouting of seeds has been known since ancient times. also in Western countries consumption of sprouted seeds increased popularity. sprouted seeds have been recognized principally on low processing and additive-free. The presence of particular characteristics such as unique color, rich flavor, and content of present bioactive compounds, could be used to enriched the sensorial properties of salads, or to garnish a wide variety of high-quality products. Moreover, sprouting may be a simple and cheap process. wheatgrass is mostly consumed as fresh juice or as tablets, capsules, and liquid concentrate. Further perspectives might be given by the utilization of cereal sprouts as supplements in animal feeding. A rise within the increase in the intake of plant-derived foods to enhance health status and prevent chronic diseases.

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Entomopathogenic Fungi – An ecological alternative to chemical pesticides

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Introduction

Insects are susceptible to a variety of diseases caused by viruses, bacteria, fungi, protozoans, rickettsia, mycoplasma and nematodes. Among them, fungal pathogens have certain advantages over other insect pathogens like bacteria and viruses and gaining importance in crop pest control in recent years. Entomopathogenic fungi are a major component of integrated pest management techniques as a biological control agent against the insect pests and other arthropods in horticulture, forestry and agriculture and are found in the divisions of Zygomycota, Ascomycota, Deuteromycota, Chytridiomycota and Oomycota. They comprise of wide range of morphologically, phylogenetically and ecologically diverse fungal species. As a group of parasites, the entomopathogenic fungi infect a wide range of insect hosts, from aquatic larvae to adult insects from high canopies in tropical forests or even deserts. Their hosts are spread among 20 of the 31 orders of insects, in all developmental stages: eggs, larvae, pupae, nymphs, and adults.

Advantages of Entomofaunal pathogens over other groups of microbial agents:

- Mass production is much simpler, easier and cheaper
- Unlike bacteria or viruses do not require ingestion
- Play an important role in natural pest control through epizootics
- No report of Resistance development for fungal pathogens
- Ideally suited component in Integrated Pest Management (IPM)

Entomopathogenic fungi for pest suppression

More than 750 species of fungi, mostly Deuteromycetes and Entomophthorales from about 100 genera are pathogenic to insects, and many of them offer great potential for pest management. Species that have been most intensively investigated for mycoinsecticides in crop pest control include *Beauveria bassiana*, *Metarhizium anisopliae*, *Lecanicillium lecanii* (= *Verticillium lecanii*), *Hirsutella thompsonii*, *Nomuraea rileyi*, *Isaria fumosoroseus* (= *Paecilomyces fumosoroseus*), *Isaria farinosa* (= *Paecilomyces farinosus*) etc (Table-1). The first two species have been used on large scale for the control of several crop pests over a number of years, while others have been attempted in recent times.

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The fungal diseases of insects are commonly referred to as mycosis. Fungi infect insects of almost all orders, most common in Hemiptera, Diptera, Coleoptera, Lepidoptera, Orthoptera and Hymenoptera. In some insect orders, nymphal or larval stages are more often infected than the adult stages, in others the reverse may be the case. Fungi rarely infect the pupal and egg stages. Some fungi have restricted host ranges, e.g., *Aschersonia aleyrodis* infects only whiteflies and scales, *Zoophthora aphidis* infects only aphids from one genus, while others like *B.bassiana* and *M. anisopliae* infect more than 700 species in several insect orders and they have several pathotypes which have a high degree of host specificity.

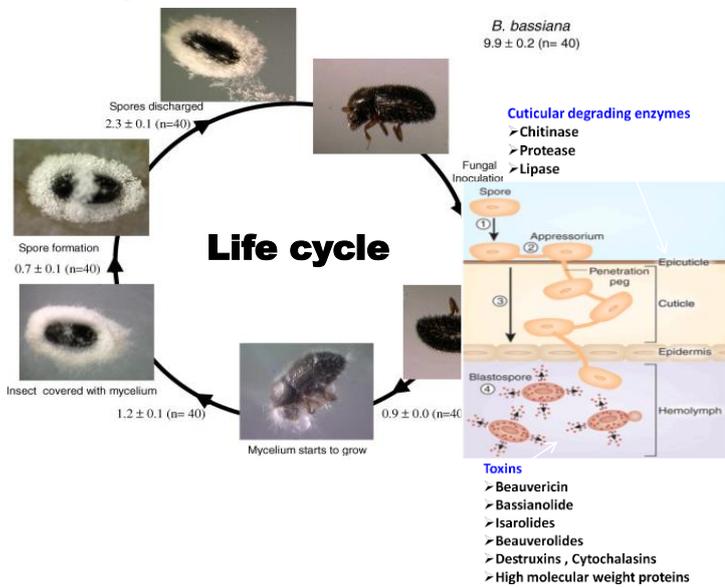
Table-1: Common Entomogenous Fungi and their Hosts.

Entomogenous fungus	Host
Zygomycotina	
<i>Entomophthora muscae</i>	Dipteran insects
<i>E. thripidium</i>	Thrips
<i>Entomophaga aulicae</i>	Lepidopteran insects
<i>E. grylli</i>	Orthopteran insects
<i>Erynia neoaphidis</i>	Aphids
<i>Massospora cicadina</i>	Cicada
<i>Neozygites fresenii</i>	Aphids
<i>Zoophthora radicans</i>	Certain Hemiptera and Lepidoptera

<i>Conidiobolus obscurus</i>	Aphids
Deuteromycotina	
<i>Aschersonia aleyrodis</i>	Whiteflies, Scales
<i>Beauveria bassiana</i>	Wide host range
<i>B.brongniartii</i>	Cockchafers and sugarcane borer
<i>Hirsutella thompsonii</i>	Spider mite, citrus red mite, coconut eriophyid mite
<i>Metarhizium anisopliae</i>	Wide host range
<i>M. flavoviride</i>	Orthopteran insects
<i>Nomuraea rileyi</i>	Lepidoptera
<i>Isaria farinose</i>	Coleoptera, Lepidoptera
<i>I. fumosoroseus</i>	Wide host range
<i>Lecanicillium lecanii</i>	Wide host range (Aphids, Whiteflies, Scales)

Fungal pathogenesis on insects: Most of the EPF infect the host through the cuticle. The process of pathogenesis begins with adhesion of fungal spore on cuticle followed by germination, penetration and development of fungus inside the host leading to the death of the host. Fungi usually cause insect mortality by nutritional deficiency, destruction of tissues and releasing of toxins. After the penetration of germinating hyphae in the haemocoel, the fungus produces hyphal bodies, hyphal strands and protoplasts that fill the haemocoel completely. Several mycotoxins

are produced by these fungi during pathogenesis and these act-like poisons for the insects (Table-2). After the death of the insects the fungus breaks open the integuments and form aerial mycelia and sporulation on the cadavers.



Symptoms of Fungal Infections on Insects

- Loose appetite, coordination, less active
- Cadavers - hard
- Cadavers - fungal growth and sporulation
- Whitish/Creamish fungal growth *B. bassiana*, *L. lecanii*
- Greenish sporulation- *M. anisopliae*, *N. rileyi*

Environmental conditions particularly humidity and temperature play an important role in the infection and sporulation of entomopathogenic fungi. Very high humidity (> 90% RH) and an optimum temperature of 25° C is required for spore germination and epizootics.

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Table 2: Toxins Produced by Entomopathogenic Fungi

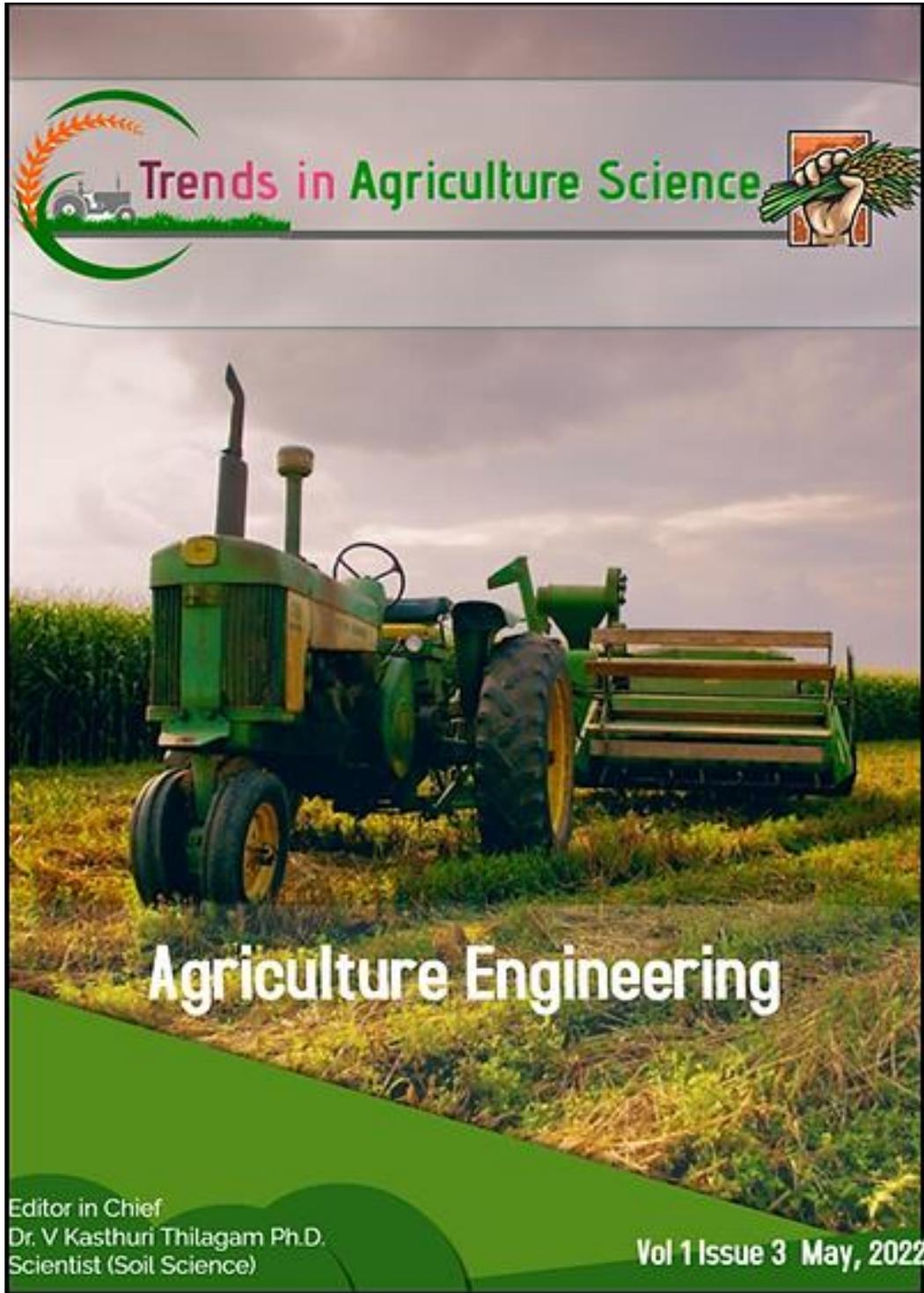
Sl. No.	Fungus	Toxin produced
1	<i>Beauveria bassiana</i>	Beauvericin, Beauverolides, Bassinolide
2	<i>B. brongniartii</i>	Isarolides A, B, C, D
3	<i>Metarhizium</i>	Destruxins A, B, C, D, E, F
4	<i>Isaria</i>	Isarin
5	<i>Lecanicillum lecanii</i>	Similar to Bassinolide
6	<i>Cordyceps miliaris</i>	Cordycepin

Table 3: Biological Control of pests using entomopathogenic fungi

Fungus	Pest & Crop	Field efficacy	Reference
<i>Beauveria bassiana</i>	Rice Hispa (<i>Diuraphis armigera</i>)	A spray of <i>B. bassiana</i> spore suspension 10 million spores/ml	Hazarika and Puzari (1997)
	Coffee berry borer (<i>Hypothenemus hampei</i>)	A spray of <i>B. bassiana</i> spore suspension (1×10^7 spores/ml) containing 0.1% sunflower oil and 0.1% wetting agent during monsoon reduced 50-60% berry borer incidence in Coorg, Karnataka	Anon. (2001)
	Tea looper caterpillar (<i>Buzura suppressaria</i>)	A spray of <i>B. bassiana</i> spore suspension (2.5 g/l), reduced 88% reduction in West Bengal	Ghatak and Reza (2007)
	Sunflower <i>Helicoverpa armigera</i>	A spray of oil suspension of <i>B. bassiana</i> (200mg/l) in Andhra Pradesh	Devi and Hari (2009)
	Green gram White grubs	Soil application @ 5×10^{13} conidia/ha effective control achieved in Assam	Bhattacharyya <i>et al.</i> (2008)
<i>Beauveria Brongniarti</i>	Sugarcane white grubs <i>Holotrichia serrata</i>	Soil application @ 1kg /acre. Highest yield recorded	Chelvi <i>et al.</i> (2010)
<i>Metarhizium anisopliae</i>	Coconut Rhinoceros beetle (<i>Oryctes rhinoceros</i>)	Spraying of Spores in its breeding sites @ 5×10^{11} spores/m ³ to the compost pits and manure heaps	Anon. (2000)
	Sugarcane White grub	<i>M. anisopliae</i> at 1×10^{13} /ha gave a yield of 91.18 q/ha as compared with chlorpyrifos (93.29 q/ha) in Karnataka.	Rachappa <i>et al.</i> (2004)
	Pigeon Pod borer <i>Helicoverpa armigera</i>	<i>M. anisopliae</i> conidia in an oil formulation was effective in reducing 66.74% <i>H. armigera</i> as compared to 62.58% with endosulfan in Maharashtra.	Nahar <i>et al.</i> (2004)
	Potato White grubs (<i>Brahmina</i>)	Soil application @ 5×10^{13} conidia/ha along with chlorpyrifos 20 EC at 200 g a.i./ha resulted in the highest tuber yield (155 q/ha) in HP.	Bhagat <i>et al.</i> (2003)
	Soyabean white grubs <i>Holotrichia longipennis</i>	Soil application formulation applied @ 5×10^{13} conidia/ha, 61.50% reduction in grub population	Pandey (2010)
<i>Lecanicilliumlecanii</i>	Coffee green scale (<i>Coccus viride</i>)	Spraying spores @ 16×10^6 spores/ml along with Tween-80 twice at 2 weeks interval caused 97.6% mortality of the pest.	Jayaraj (1989)
	Citrus green scale (<i>Coccus viride</i>)	Spraying of spore (2×10^6 spores/ml) along with 0.005% quinalphos and 0.05% Teepol was found highly effective in killing 95.58% and 97.55% scales in coffee and citrus respectively	Singh (1995)
	Indian mustard and Rapeseed-Mustard aphid <i>Lipaphis erysimi</i>	Spray @ (10^6 spores/ml). There was a significant reduction in aphid infestation at 10 DAS.	Rana <i>et al.</i> (2002)
<i>Nomuraea rileyi</i>	Castor <i>Spodoptera litura</i> in AP	Spraying of spore (10×10^{10} spores/ml) along with 0.02% Tween-80.	Vimala Devi and Prasad (1997)
	Soybean <i>Spodoptera litura Helicoverpa armigera Thysonoplusia orichalcea</i>	<i>N. rileyi</i> spores spraying @ 2×10^8 /ml twice at 10 days intervals during Kharif in North Karnataka. Cheaper than insecticidal treatment and cost effective.	Lingappa <i>et al.</i> (2002)

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Gardens for Biodiversity Conservation

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Introduction

A garden is a planned planted space, usually outdoors, used for cultivation, display, conservation, and aesthetic purposes. Earlier, people had to visit tourist spots to see the beauty of gardens. Which were only available in the government-run botanical gardens or zoological gardens. Nowadays the concept of gardens is more prevalent in schools, colleges, institutions, industries, corporate buildings, government buildings, Heritage sites, and even in our backyards. The students in schools and colleges are taught about the importance of having a green garden. There is also an evolution of a separate discipline called Landscape Architecture to deal with the design and development of the gardens depending on the customer's needs. However, people still perceive a garden as more of aesthetic value than environmental value. Hence, this article is written to instigate the ecological value of the garden to the common people and how gardens can be used for conserving local biodiversity.

Forms and Purpose of the garden

It is true that the gardens are created to satisfy different needs and the purpose varies with gardens, locations and customers (Table 1). For instance, The Botanical Garden of Ooty was started by the British people with the purpose of introducing plants. They succeeded in introducing tea, coffee, potato, wheat, eucalyptus, wattles, silver oak and many conifers to India and Nilgiris. Likewise, The Nandankanan Zoological Park of Odisha is a zoological garden working with the purpose of preserving and breeding white tigers. Irrespective of the differences in the purpose of their establishment, all gardens serve the universal purpose of conserving biodiversity. It is not impossible to achieve higher biodiversity conservation by adding a few more ideas to the already existing gardens.

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Table 1: Various gardens and their purposes

Name of the garden	Main Purpose
Arignar Anna Zoological Park, Vandalur, Chennai	: Ex-situ propagation of critically endangered species
Snake Park, Guindy	: Captive breeding of endangered snake species
Ranthambore National Park	: Tiger
Gir Forest National Park, Gujarat	: Asiatic Lion
Bhitarkanika National Park, Odisha	: Saltwater crocodile
Blackbuck National Park, Velavadar, Gujarat	: Blackbuck
Clouded Leopard National Park, Tripura	: Clouded Leopard
Dachigam National Park, J&K	: Kashmir stag
Desert National Park, Rajasthan	: Great Indian Bustard
Mukurthi National Park, Tamil Nadu & Eravikulam National Park, Kerala	: Nilgiri Tahr
Gulf of Mannar Marine National Park	: Marine species
Arboretum	: Education & Conservation of trees
Kitchen garden	: Food production
Public garden	: Recreation
Gardens in schools	: Providing shade and aesthetic value
Gardens in the industrial complex	: Dust reduction, shade and aesthetic value
Gardens in a corporate office	: Aesthetic value

The need for conservation garden

The perception of natural beauty varies with person and many of us don't admire the native beauty. The beauty of an asymmetric garden with a nicely mowed lawn, interspersed with circular and rectangular pathways attracts the people more than a native shrub with thorny bushes and trees bearing non-edible fruits on undulating terrain. But for a naturalist, the latter is more beneficial as he appreciates the ecological stability, sustainability and diversity of flora & fauna within it. The role of each and every organism in an ecosystem is very important and we (humans) are in a position to provide enough space for other organisms to live. This is not only necessary for the survival of the other organisms but also for us also. We may find the above statement in various famous quotes as follows (Table 2).

Studies indicated that the insects like butterflies, bees and dung rollers are decreasing at a rapid rate and predicted extinction of over 40% of the insect species in the next few decades (Sánchez-Bayo and Wyckhuys, 2019). Likewise, more than 14000 species, i.e. 28% of all assessed species, are threatened with extinction (IUCN, 2022). Before twenty years, even the seasonal rivers like Vaigai and many water reservoirs in the southern part of Tamil Nadu were teamed with different varieties of fish. The decline in diversity of endemic birds, animals and plants can be easily observable to all who are in their mid-30s. In the middle of a technology driven world, people should learn to observe and appreciate natural beauty rather than the man-made landscape. Then only one can really understand the need and contribute to the conservation of biodiversity.

How to achieve conservation garden

Owing to the advent of social platforms, nowadays people are more aware of biodiversity, but, in an intangible way. The pint of the real action is missing in a major chunk of people. However, everyone can get into action to conserve biodiversity by acting on any of the following points discussed.

Basic documentation of local fauna and flora is the prerequisite for any conservation purpose and hence irrespective of place, people should develop a

habit of observing and identifying the local flora and fauna. **Table 2: Quotes and findings**

A world without	Quotes/ Predictions	References
Bees	They pollinate 70 of the around 100 crop species that feed the world	https://www.bbc.com/future/article/20140502-what-if-bees-went-extinct
Bees	If the bee disappeared off the surface of the globe, then man would have only four years of life left. No more bees, no more pollination, no more plants, no more animals, no more man.	Albert Einstein
Birds	The plant species, which are depending on birds for pollination and dispersal, will die. Many small animals like weasels, wild cats depending on birds for food may disappear. Insect damage to crops will increase	https://voice.gardenbird.co.uk/imagine-a-world-without-birds/
Birds	A world without poetry and art would be too much like one without birds or flowers: bearable but a lot less enjoyable	Aberjhani
Nematodes	In short, if all the matter in the universe except the nematodes were swept away, our world would still be dimly recognizable, and if, as disembodied spirits, we could then investigate it, we should find its mountains, hills, vales, rivers, lakes, and oceans represented by a film of nematodes. The location of towns would be decipherable, since for every massing of human beings there would be a corresponding massing of certain nematodes. Trees would still stand in ghostly rows representing our streets and highways. The location of the various plants and animals would still be decipherable, and, had we sufficient knowledge, in many cases even their species could be determined by an examination of their erstwhile nematode parasites	Nathan A. Cobb
Microbes	Don't forget that the flavors of wine and cheese depend upon the type of infecting organisms	Martin H. Fischer
Plant and Animals	Humans are a great survivor species but our survival will be pretty grim if all of the plants and animals we depend on die out. That's why any human survival strategy has to include a plan to maintain our environment roughly in the state that it's in now.	Annalee Newitz
Humans	If we [humans] disappeared overnight, the world would probably be better off	David Attenborough
Humans	Humans are the one species the world could do very well without	George Schaller

All the temples in south India harbour sacred trees in the name of “*Sthala Viruksham*”. These trees are actually the dominant tree species in the area surrounding the temple. For instance, the sacred tree in Mangalanatha Swamy temple in Uthirakosamangai at Ramanathapuram district of Tamil Nadu is the Indian Ber tree (*Ziziphus mauritiana*) and it was the dominant species in these dry tracts. Likewise, many temples have different sacred trees depending on their locations. Therefore,

preference should be given to conserving and planting these trees in the surrounding area rather than planting *Polyalthia* sp. or bottle palm or ornamental palm etc.

The gardens on office premises may have flowering plants, native trees and shrubs rather than lawns. These lawns are easy to maintain but will not give liveliness by attracting birds or insects (**Fig 1**).

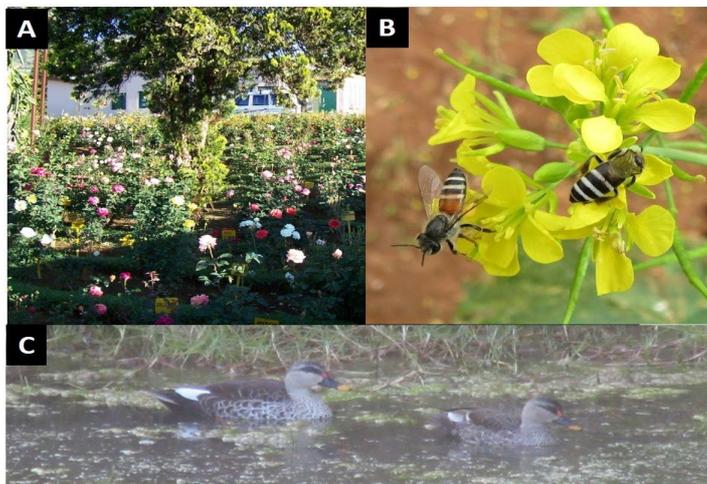


Fig 1: Rosegarden (A) and mustard crop (B) attract more number of Hymenopterans at ICAR-IARI, Regional Station, Wellington; C-Birds attracted to the artificial pond at ICAR-CPRS, Regional center, Muthorai

Individuals in their garden may do the activities such as planting native fruit bearing trees in place of ornamental trees; adding flowering plants to attract bees, butterflies and other pollinators; adding a bowl of water and perching spot for birds; knowledge about invasive species; reducing pesticide usage etc.

Developing a hobby such as birding, hiking, fish hooking, aquarium, gardening and pets rearing helps to create more realistic bonding towards the biodiversity among the school children and college students. These kinds of hobbies will positively educate the children and inculcate the character of appreciating nature including the local flora and fauna.

In a country like India with diverse languages, advertisements about biodiversity and conservation should appear in local languages in all media in regular intervals rather than, only during world forest day or earth day.

Conclusion

Conserving the flora and fauna that are visible to human eyes are very important. At the same time, the significant role played by invisible microbial organisms like earthworms, nematodes, tardigrades, protozoans, bacteria, fungi in the ecosystem should not be ignored. All organisms, whether big or small within an ecosystem are coevolved to support each other in their survival. Recent scientific advances are targeting the role of such microbes (endophytes and PGPR) in benefiting agricultural crops.

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