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Growing seed

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IMPORTANCE & BIOLOGY OF OILSEED *Brassica* species

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Rapeseed–mustard crops in India are grown in diverse agro-climatic conditions ranging from north-eastern/north-western hills to down south under irrigated/rainfed, timely/late sown, saline soils and mixed cropping. Indian mustard accounts for about 75-80% of the 5.8 million hectares (mha) under these crops in the country during 2009-10. The cultivation of brown sarson which once dominated the entire rapeseed-mustard growing region is now shadowed by Indian mustard. There are two different ecotypes of brown sarson: lotni (self-incompatible) and tora (self-compatible). The 'lotni' is predominantly cultivated in colder regions of the country particularly in Kashmir and Himachal valley. The'tora'on the other hand is cultivated in limited areas of eastern Uttar Pradesh. Yellow sarson is now mainly grown in Assam, Bihar, north-eastern states, Orissa, eastern Uttar Pradesh and West Bengal. Toria is a short duration crop cultivated largely in Assam, Bihar, Orissa and West Bengal in the east mainly as winter crop. In Haryana, Himachal Pradesh, Madhya Pradesh, Punjab, Uttarakhand and western Uttar Pradesh, it is grown as a catch crop. Taramira is grown in the drier parts of north-west India comprising the states of Rajasthan, Haryana and Uttar Pradesh. Gobhi sarson and karan rai are the new emerging oilseed crops having limited area of cultivation. Gobhi sarson is a long duration crop confined to Haryana, Himachal Pradesh and Punjab. Rapeseed-mustard crops because of their low water requirement fit well in the rainfed cropping system of resource poor farmers.

Importance

The oleiferous *Brassica* species, commonly known as rapeseed-mustard, are one of the economically important agricultural commodities. Rapeseed-mustard comprising eight different species viz., Indian mustard, toria, yellow sarson, brown sarson, gobhi sarson, karan rai, black mustard and taramira, are being cultivated in 53 countries spreading all over the globe. The oil and protein content varies from 37 to 49% and 22-28%, respectively. The seed and oil are used as condiment in the preparation of pickles and for flavouring curries and vegetables. The oil is utilized for human consumption throughout the northern India in cooking and frying purposes. It is also used in the preparation of hair oils and medicines. It is used in soap making, in mixtures with mineral oils for lubrication. Rapeseed oil is used in the manufacture of grease. The oil cake is used as feed and manure. Green stem and leaves are a good source of green fodder for cattle. The leaves of young plants are used as green vegetable as they supply enough sulphur and minerals in the diet. In the tanning industry, mustard oil is used for softening leather. Rapeseed-mustard oil contains lowest level of saturated fatty acids among all vegetable oil, which is quite desirable for good health. Both the essential fatty acids (EFA) such as linoleic acid (C18:2) and linolenic (C18:3), are present in rapeseed-mustard oil. Rapeseed-mustard oil has high level of antioxidant, which retards growth of free radicals mainly responsible for disease like cancer and ageing. Glucosinolates present in seed meal has shown anticancer properties. *Brassica* species are very rich in phenolic compounds and glucosinolates. Rapeseed-mustard crops in India comprise traditionally grown indigenous species, namely toria (*Brassica campestris* L. var. toria), brown sarson (*Brassica campestris* L. var. brown sarson), yellow sarson (*Brassica campestris* L. var. yellow sarson), Indian mustard [*Brassica juncea* (L.) Czern & Coss], black mustard (*Brassica nigra*) and taramira (*Eruca sativa/vesicaria* Mill.), which have been grown since about 3,500 BC along with non-traditional species like gobhi sarson (*Brassica napus* L.) and Ethiopian mustard or karanrai (*Brassica carinata* A. Braun).

Table-1: Systematic position of *Brassica* Species.

Benthum and Hooker	Engler and Prantle	Hutchinson
Division - Spermatophyta	Division - Embryophyta	Phylum - Angiospermae
Class - Dicotyledons	Sub-Division - Angiospermae	Sub-Phylum - Dicotyledonae
Sub-Class - Polypetalae	Class – Dicotyledonae	Division - Archichlamydae
Series - Thalamiflorae	Sub-Class - Archchlamydae	Sub-group - Herbacae
Order - Parietales	Order – Rhoedales	Order - Cruciferae
Family - Brassicacae	Family – Brassicacae	Family - Cruciferae

Floral Biology of *Brassica* Species

Flowers of both the species have 4 sepals and 4 petals of deep yellow to pale yellow colour. Four flower has 6 stamens; 4 with long and 2 with short filaments. The pistil is compound and the ovary matures into a 2 celled fruits. It is made up of 2 carples, which are separated by a false septum, thus providing 2 chambers.

Floral Parts (General for *Brassica*)

Flowers: Regular and cruciform, bisexual and complete, hypogynous, ebracteate.

Calyx: Sepals 2 + 2, free, in two whorls.

Corolla: Petals 4, free, in one whorl, valvate, cruciform with distinct limb and claw, imbricate.

Androecium: Stamens 6, in two whorls-2 outer short and 4 inner long, tetradynamous.

Gynoecium: Carpels 2, syncarpous, ovary superior, at first 1- celled, later 2- celled owing to the development of a false septum called replum, placentation parietal.

Inflorescence: Long racemose.

Fruits: A siliqua.

Seeds: Ex-albuminous.

Floral formula: K_{2+2} Cx4 A_{2+4} $G_{2.}$

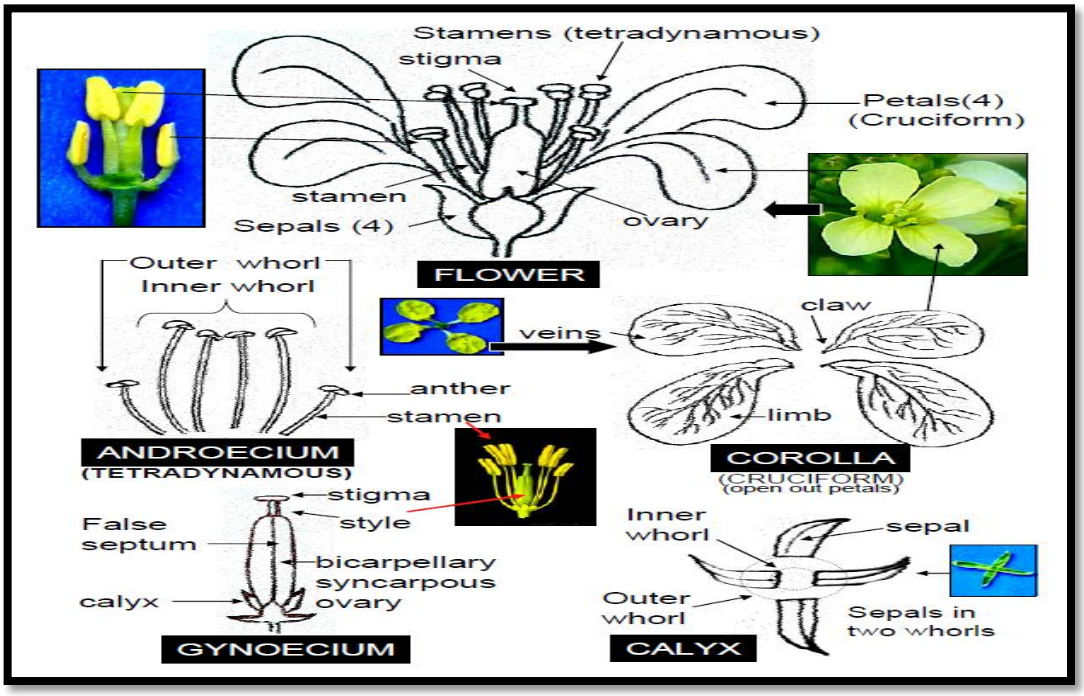

Fig.- 1: Flower Parts of Rapeseed And Mustard

Cultivated Species

Rapeseed *i.e. Brassica campestris* (2n = 20) is one mainly cultivated species. This species has three ecotypes, *viz.* Yellow sarson (*Brassica campestris* var. yellow sarson), brown sarson (*Brassica campestris* var. brown sarson) and toria (*Brassica campestris* var. toria). Yellow sarson and brown sarson are collectively called as turnip rape, and toria is known as Indian rape. The other cultivated species is *Brassica napus* (2n = 34). In India, there are two main cultivated species of mustard, *viz.*, Rai or Indian mustard (*Brassica juncea* 2n = 4x = 36) and Banarasi Rai or black mustard (*Brassica nigra* 2n = 16).

Table-2: Commonly grown species of rapeseed and mustard

Common name	Botanical name	Local name
Indian mustard	*Brassica juncea* Coss	Rai or laha
Rugosa	*Brassica juncea* var. rugosa	Pahari rai
Black mustard	*Brassica nigra* Koch	Banarasi rai
Yellow sarson	*Brassica campestris* L. var. yellow sarson	Yellow sarson
Brown sarson	*Brassica campestris* L. var. brown sarson	Brown sarson
Indian rape	*Brassica campestris* L. var. Toria	Toria or lahi
White mustard	*B. alba*; *B. hirta* Moench	Ujli sarson
Rocket cress	*Eruca sativa* Mill	Taramira

Characteristics Features of Some Important Types

1. **Toria (*Brassica campestris* var. toria).** It is grown as an autumn crop. This variety is susceptible to cold and is sown early in middle or late September and takes about 75-100 days to mature. The variety is obviously low yielding but it responds to irrigation and adequate fertilization.

2. **Yellow and sarson (*Brassica campestris* var. *glauca* and var. *dichotoma*).** It is widely grown in North and Central India. There are two main types yellow sarson and brown sarson so named because of its seed colour. It is high yielding than ‘toria’ and brown sarson and also from yellow ones. The crop is sown in October and harvested in March/April after 150-160 days time.

3. **Brown or Indian mustard (*Brassica juncea*).** It is very widely grown in India. The crop is sown in October/November and harvested in March/April after about 110-160 days period. This type gives better yield than *Brassica napus*.

4. **Black mustard (*Brassica nigra*).** It is grown in very limited area. It has very low oil content into it but the main purpose of its cultivation is to use it as condiment.

5. **Taramira (*Eruca sativa*).** It is relatively of recent introduction into India. It is believed to be native of south Europe and north Africa. It is relatively a low yielding cruciferous oilseed crop grown in northern India and very often grouped with rape and mustard crops. The variety is particularly adapted to poor soils and low rainfall areas.

Table-3: Classification of rapeseed and mustard grown in India

Indian group	International commercial name	Species	Common name	Local name	Ch. No. (n =)
Sarson	Indian colza, Colza rape	*Brassica rapa* var. yellow sarson	Turnip rape	Yellow sarson	20
		Brassica rapa var. brown sarson	Turnip rape	Brown sarson	20
Toria	Indian rape	*Brassica rapa* var. yellow toria	Indian rape	Yellow toria or lahi	20
		Brassica rapa var. brown toria	Indian rape	Black toria or lahi	20
Rai	Mustard	*Brassica juncea*	Indian mustard	Rai or raya or laha	36
		Brassica juncea var. rugosa	Rugosa	Pahari rai	36
		Brassica nigra	Black mustard	Banarasi rai	16
Dhauli Rai	White sarson	*Brassica hirta*	Ujli sarson	-	-
Taramira	Rocket cress	*Eruca sativa*	Duan	-	-

Crossing Techniques

In the selected plants racemes are to be selected in which flowers will be utilized for crossing. Keeping 6-8 flowers on the lower side the rest of the raceme is to be clipped off. Generally, 2-3 flowers open at a time. Selecting such buds which will open next day, the corolla is to be slit open by the fine tip of the pincer and the anthers will be removed just by jerking to achieve emasculation. Though pollen grains of the same flower will not be effective for pollination for the operation of self-incompatibility system, for the sake of ensuring purity of the cross, emasculation is necessary. The raceme with the emasculated flowers is to be covered by brown paper bags to save the flowers from contamination by unwanted pollen grains. The male parental plants from which anthers will be collected for dusting pollen grains on the stigmatic surface, are to be kept covered by fine cloth bags and flowers allowed to open under cover. Before taking up crossing programme, a study is to be made to know actually when the opening of the flowers and dehiscence of anthers take place. When in the morning the flowers open, striking the time just before dehiscence of the anthers, these are collected in a watch glass or such anthers also can be collected which have just started dehiscing. If undehisced anthers are collected, time has to be given for its bursting. When with the help of magnifying glass the dehiscence/bursting if the anthers is observed, the whole anthers are lifted with the help of the fine forceps and taken on the stigma to touch the surface for pollination. After touching the stigmas with the burst anthers, it is to be checked with the help of the magnifying glass (3 or 4 X will do) whether the pollen grains are found on the stigmatic surface. After pollination the paper bag is to be replaced, so also the cloth bag protecting the plants with flowers used as pollen source. After pollinating all the flowers retained in the raceme the bag may be removed giving a proper tag to identify the crossed flowers.

Reproduction and Pollination

Brassica juncea and *Brassica napus* are self pollinated species. yellow sarson (*Brassica campestris* var. yellow sarson) is also self pollinated. *Brassica campestris* viz., brown sarson and toria are self incompatible. *Brassica nigra* and *Brassica oleracea* are also self incompatible. Self incompatibility promotes cross pollination in these species which occurs by wind and honey bees. Rapeseed produces yellow nector-bearing flowers, which are able of both self-fertilization and intra specific cross-fertilization. Honeybees are the primary pollinators of rapeseed. In India, isolation distance of 400 meters for foundation seed production is required.

Stigma Receptivity: The stigma become receptive 3 days before blooming of the flowers and remain so 3 days after anthesis. Breeder can hence plan their crossing work according to the convenience.

Anthesis: Dehiscence of the anthers takes place around 8 AM in the morning depending upon the weather condition. If cloudy the anthers is delayed till the sun breaks. Warmth of the weather imparted by sun is necessary for dehiscence.

Pollen Grains and Viability: Pollen grains are round in shape taking stain readily and remain viable for 24 hours after release from the anther sacs.

Blooming of The Flowers and Anthesis: The flowers being to open by 8 AM with the rise in atmospheric temperature. The process continues till noon. Since it is a racemose type of inflorescence the flowers placed lower in the raceme open first continuing to proceed upwards each day. This continues for a week or so depending upon the growth of the inflorescence.

Synchronized Flowering of Male and Female Parents: Oilseed *brassicas* have indeterminate flowering habit. Early onset of flowering in the female parent as compared to the pollen parents invariably results in female plants getting taller. This reduces the hybrid seed set as the access of the pollen to the stigma is reduced. Detopping of alternate plant of male parent (in 2M : 4F/2M : 6F) ratio coupled with additional application of N (@ 25 kg/ ha) between pollinator rows after flowering was found effective to ensure pollen supply for longer duration.

Maintenance of Purity: In *Brassica juncea* and yellow sarson maintenance of purity of the lines is not difficult. This is achieved by covering the whole plants with fine cloth bag and leaving them as such. Since both the species are self-compatible pollination brought about by the pollen grains of the same flower results in fruit and seed setting. It is found that if the bags are shaken in the morning the seed setting is better. By shaking the cloth bags along with the plants dusting of pollen grains liberated by the anthers, is ensured though by structure and biology of the flower, dusting is not necessary to ensure pollination. Further, keeping the plants open for some time after the pollination is over in the morning, ensures better pod setting.

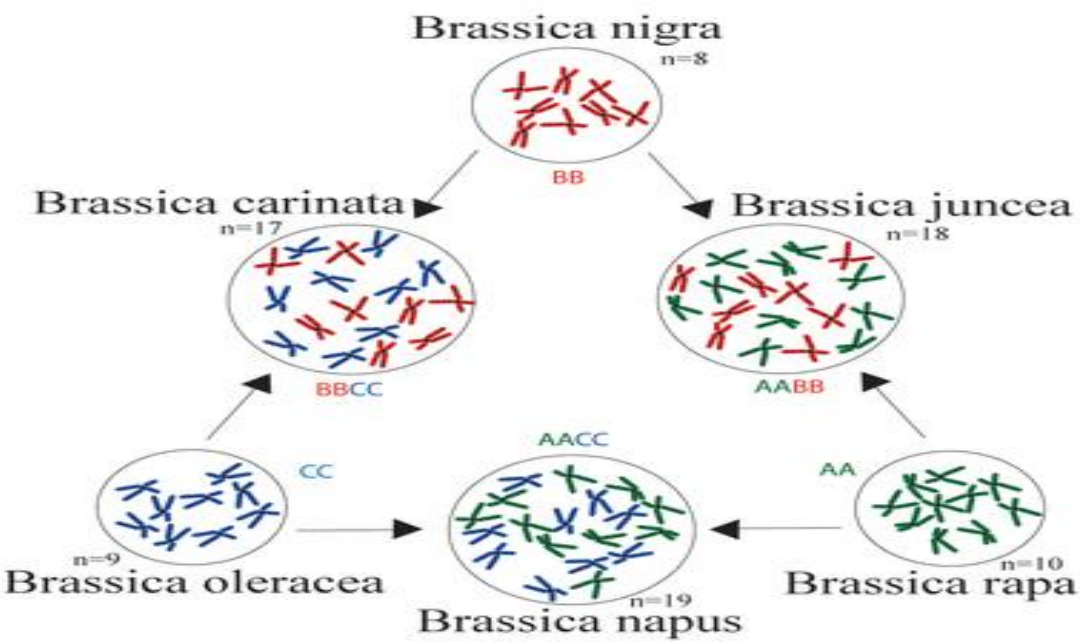

Fig.-2: 'U'-triangle of *Brassica* species (Nagaheru, 1935).

Conclusion

Important oil seed crop grown in cool season sub tropics, higher elevations and winter crops. Rapeseed oil was produced in the 19th century as a source of a lubricant for steam engines. It was less useful as food for animals or humans because it has a bitter taste due to high levels of glucosinolates. Varieties have now been bred to reduce the content of glucosinolates, yielding a more palatable oil. This has had the side effect that the oil contains much less erucic acid. The oil and protein content varies from 37 to 49% and 22-28%, respectively. The seed and oil are used as condiment in the preparation of pickles and for flavouring curries and vegetables. The oil is utilized for human consumption throughout the northern India in cooking and frying purposes. It is also used in the preparation of hair oils and medicines. It is used in soap making, in mixtures with mineral oils for lubrication.

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COMMODITY FUTURES TRADING IN INDIA–POTATO SCENARIO

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Derivatives are the financial contracts that derive their value from the value of the underlying asset. The trading in the modern securities involves a mammoth risk and a proficient way of dealing with them are the derivatives. The most prominent four types of derivatives are forwards, futures, options and swaps. Forwards are the customized contracts made between the buyer and seller to exchange an asset, whereas, futures are the standardized contract in which the deals get fixed through exchange mode. Options are the contracts that provide rights to buy and sell an asset but not the obligation of real buying and selling. Swaps are the most complex agreements as they are made privately between the parties and their trading does not takes place in stock exchange but through a middleman of investment banker.

Futures involves number of players and its perspective differs according to the players in the futures market. According to buyers and sellers, futures trading is generally an agreement where the seller is obliged to sell a certain quantity of any asset and buyer is obliged to pay the pre-agreed price in the future date at a pre-agreed place. On the other hand, for speculators and hedgers, futures trading is a tool for profit maximization and loss minimization, respectively (Rana *et al.*, 2008). The types of futures contract are subjected to the types of assets traded such as equity, stock market index, commodity, currency and interest rate futures. The market place where this kind of buying and selling takes place are called as futures markets.

The three major activities that differentiate the conventional markets and futures markets are speculation, hedging and price discovery.

i) **Hedging** is the process of protecting oneself (hedgers) from the price risk like high price for the buyers and low price for the sellers.

ii) **Speculation** is the process of predicting or guessing about the future prices by speculators which is always seen to be the main reason for price fluctuation.

iii) **Price discovery** is the process where the prices determined by supply and demand are discovered.

The main purposes of futures trading are to transfer cash or price risk, discover prices and provide public access to information about the markets.

History of Futures Market

The development of the futures markets over the years across the world and in India is mentioned in the following table.

Year	Major activities
1710	1st modern organized futures exchange (Dojima Rice Exchange) in Osaka, Japan
1750	First ever legal code of futures trading in Ancient Mesopotomia
1848	Chicago Board of Trade (CBOT) – standardized the futures trading
1875	1st futures trading of cotton by Bombay Cotton trade association
1877	London Metal Exchange (LME)
1952	1st organized futures trading in India – Forward Market (Regulation) Act
1953	Forward Market Commission (FMC)
1960s	Ban of futures trade of all commodities except pepper and turmeric in India
1980	Potato futures trading on the recommendation of Khusro committee in India
1999	Futures trading of oil seed complexes in India
2000	Additional 54 commodities were permitted for futures with advent of National Agricultural Policy (NAP)
2001	Inter-Continental Exchange (ICE)
2002	National Multi-Commodity Exchange of India (NMCE)
2003	All agricultural commodities were permitted to trade in futures Multi-Commodity Exchange of India Ltd. (MCX) and National Commodity and Derivatives Exchange of India Ltd. (NCDEX)
2005	African Mercantile Exchange (AME)
2006	New York Stock Exchange
2014	Curbing of potato futures trading in India by MCX
2015	FMC merged with SEBI

Commodity Exchanges

The functioning of futures markets had over run its purpose in past few years increased speculation led to drastic increase in prices and caused inflation in the country. In order to take effective control of functioning of futures markets, the central government handed over its power to Securities and Exchange Board of India (SEBI) and FMC merged with SEBI in 2015. Futures trading are carried out in various commodities in India *viz.*, Edible oilseed complexes including groundnut, mustard seed, cotton seed, sunflower and soy oil, food grains like cereals, pulses and maize, fibers like cotton and jute, spices such as turmeric, pepper and cardamom, metals such as gold, silver, copper, zinc and aluminum, energy like crude oil and natural gas and miscellaneous commodities like sugar, jaggery, castor seeds and rubber.

India have totally 24 recognized exchanges out of which three are national exchanges and other 21 are product-specific. The national exchanges are the trading platforms for various agricultural as well as non-agricultural commodities in the country. Multi-Commodity Exchange of India Ltd. (MCX) is the most popular and widely reached futures trading platform established in 2003, headquartered at Mumbai focusing more on non-agricultural commodities like energy, petrochemicals and metals but also trade in agricultural commodities like spices, fibers, cereals, plantations, pulses, oil and oilseeds. National Commodity and Derivatives Exchange of India Ltd. (NCDEX) is the only exchange promoted by national institutions like NABARD, NSE, LIC and ICICI, that is famous for its online trading in agricultural commodities like barley, wheat, soybean, coriander, cotton, palm oil and guar. National Multi-Commodity Exchange of India (NMCE) started futures trading in November 2002 but merged with Indian Commodity Exchange (ICEX) in 2017. ICEX is an online trading platform that was recognized as an exchange in October 2004. Spices, oil, oilseeds, plantation, cereals, diamond and steel are the commodities traded by ICEX (Dummu, 2009).

Potato Futures Trading

The price of any commodity is generally determined by two major forces *i.e.*, demand and supply. In view of the agricultural commodities, the supply shows a great variability due to their seasonality, while the demand for agricultural commodities are said to be less elastic or inelastic. This disparity in demand and supply grounds for the wide fluctuations in prices and mainly paves the way to inflation. One of the measures to tap the positive and expedient side of these price fluctuations is the futures trading. However, the current state of commodity futures trading has been much debated by the policy makers which is attributed to the speculative trading of commodities. This led to the increased prices of commodities, followed by inflation over the past few years in the country. Accordingly, Forward Market Commission (FMC) has imposed bans and restrictions on trading agricultural commodities through futures contracts.

Potato (*Solanum tuberosum)* is a semi-perishable and bulky commodity. It is the highest produced vegetable in the country with 56173 million tonnes for the year 2021 (GoI, 2021). Moreover, potatoes were traded successfully through futures contract over MCX and NCDEX exchange platforms until the introduction of potato bonds in 2012. But in 2014, MCX sought after SEBI to discontinue its futures contracts on potato. The curbing in trading potato futures were mainly due to the increased investment in potato bonds rather than potato as a physical commodity and it led to the raise in spot prices of potato. In addition, lack of liquidity, broad-based participation and adequate stock of potatoes in the warehouses accredited to MCX also contributed to the ban in potato futures trading. However, the impact of COVID pandemic had led to the drastic decline in the prices of crude, palm oil, corn, wheat along with potatoes leading to huge volatility and causing loss to farmers as well as Fast Moving Consumer Goods (FMCG) companies. The importance of hedging platforms in managing price risks of any commodities were realized and highlighted as a result of the pandemic. This intrigued MCX in re-launching futures trading of potato which can check and stabilize the prices of the commodity. Consequently, in the year of 2020, MCX had sought approval from SEBI to kick start the futures trading of potato as it would benefit the players in the futures market.

Conclusion

India is a country where 54.6 per cent of the population are dependent on agriculture and about 18.8 per cent of GDP is contributed by the agricultural sector (GoI, 2022). In the era of globalization, it becomes necessary for the country with vast scope for producing large number of commodities to compete in the competitive markets to develop its economy and improve the livelihood of majority of its population. Hence, there arises a need to strengthen the marketing pattern of agricultural commodities considering their seasonality to avoid wastages and losses in terms of quality and profits. The role of futures as a derivative comes into play in this situation which would help in stabilizing the prices of commodity without causing any economic imbalances. Speculation is considered to be the biggest problem of futures trading not only in India but also all over the world. A clear-cut idea about the factors that are causing price risk is a pre-requisite to implement measures in accordance with the problem rather than banning the whole trade. Otherwise, futures trading is one of the best platforms in aiding farmers with remunerative returns provided that the complete regulation and control are taken up by the Forward Markets Commission.

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IMPACT OF CHEMICAL FERTILIZERS AND ORGANIC MANURE ON VEGETABLES PRODUCTION AND HUMAN HEALTH

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Agriculture plays a vital role in the Indian economy. With 70 per cent of the rural households about 18% to the total GDP and employment to over 60% of the population as a largest provider of livelihood, horticulture, emerged as interactive passion of Indian agriculture which contributes 30.7 percent of agricultural GDP with only 8 percent of area allocated to horticulture included fruits, spices, plantation and vegetables etc. Production of Fruits and Vegetables in India currently pegged at level of 314.67 million tones (NHB, 2018).

Vegetables play a major role in daily human diet, since they are most important source of vitamins and minerals, are required for maintaining of good health. Since India's population is mostly vegetarian, vegetables are the most important component of vegetarian diet of Indian population. The present production in India is approx 187.5 million tones of vegetable from 10.1 million hectare of land .As far as vegetable consumption per capita per day is concerned at present it is below the requirement g/capital/day, where as according to nutritional experts it should not be less than 300g/capita/day. To fill up this consumption gap of vegetables, India need to enhance its vegetable production so as to make excess a minimum of 300 gm vegetable availability per capita per day .

The role of vegetables as an essential and supplementary food in our daily diet is important as they do not only adorn the dish but also enrich the health of human being. They are bulky food and form the main source of roughages in diet. Among the different groups of vegetables, the leafy vegetables occupy special importance for carotene (vitamin 'A'), ascorbic acid (vitamin 'C') and riboflavin (vitamin 'B2'). Vegetable helps in digestion of concentrated foods.

Fertilization increases efficiency and obtains better quality of product recovery in agricultural activities. It is one of the most important ways.

Modern systems of agriculture use large amounts of fossil fuel energy, water, chemical fertilizers and pesticides to produce huge quantities of crop or live stock. Mechanized and chemical based farming, commercial farming, contract farming and genetic farming swing biotechnology are the types of modern agriculture. Keeping in mind that the amount of land used for food production and changed very slightly over the past few decades , and may even have decreased in parts of the world due to urbanization, the nutrient load per unit area is steadily increasing. This is help to the improvement of food production and save the money. Globalization and the new market economy have influenced the dietry habits of the people in the developing countries. The new diverse demands of exotic species of crops, vegetables and fruits have introduced changes in the traditional agriculture patterns and practices. If we eat a lot, our body naturally bloats up and tells us to exercise and come back to shape. When we exercise too much, our body tells us to slow down and relax. If there is rain, we also get the Sun, each and everything works fine till a balance is maintained. And we all know the consequences of imbalance.

Role of NPK in Plant Growth

The three most important nutrients, without any one of which plants could not survive, are referred to as the primary macronutrients: Nitrogen (N), Phosphorus (P), and Potassium (K).

1. Nitrogen is a key component in many of the processes needed to carry out growth. In particular, nitrogen is vital to chlorophyll, which allows plants to carry out photosynthesis (the process by which they take in sunlight to produce sugars from carbon dioxide and water).
2. Phosphorus also plays a role in an array of functions necessary for healthy plant growth, contributing to structural strength, crop quality, seed production, and more. Phosphorus also encourages the growth of roots, promotes blooming, and is essential in DNA.
3. Potassium is also vital in a variety of other processes that contribute to growth and development. Potassium is often referred to as the "quality element," because of its contribution to many of the characteristics we associate with quality, such as size, shape, colour, and even taste, among others.

Role of Organic Manure

The use of organic-based fertilizers in sustainable agriculture benefits farmers, growers, consumers and the environment in many ways. As empirically demonstrated, organic-based fertilizers help to:

- Boost both nutrient efficiency and organic matter content in the soil.
- The soil with organic matter that reduces dependency on chemical inputs.
- Restore and maintain soil fertility to nurture plant growth.
- Enhance the biological activity and biodiversity of soils.
- Enhance crop resistance to erosion by improving the soil's organic matter content.

Advantages & Disadvantages of Organic Fertilizers

- Advantage:

1. Balance the soil ecosystem, boosts plant health naturally
2. There are all natural.
3. The process of decomposition requires no chemical intervention.
4. Organic fertilizers don't upset the balance in the soil because they don't leave behind any artificial compounds.
5. Delivers nutrients in a slow, but sustainable rate.
6. They increase the crop yield and provide enough food to feed the large population.

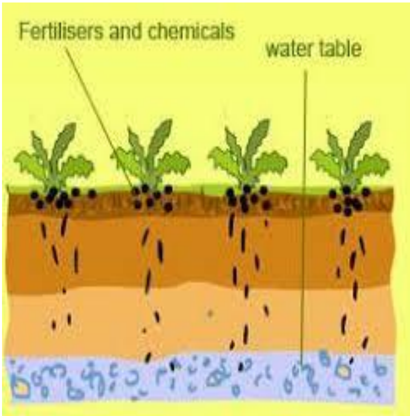
- Disadvantages

1. They are expensive.
2. NPK directly affects plant growth by feeding the plant.
3. Long term use reduces the microbial activity and disturbs the pH of the soil.
4. The ingredients in the fertilizers are toxic to the skin and respiratory system.

Effect of Chemical Fertilizers on Environmental Pollution

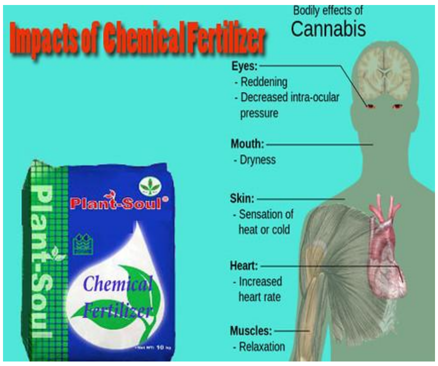
Pollution is contamination of air, water or soil by substance that are harmful to living organisms. In simple manner any direct or indirect alternation in any property, any component from the environment, which disturbs the original functioning of the same. This change is also harmful to man or any living organism. Pollution means the substance in any form of matter. i.e. solid, liquid or gaseous which cause the pollution. A fertilizer is a natural or synthetic substance that is applied to soils to supply one or more nutrients essential to the growth of plants. They contain main plant macronutrients like N, P2O5, K2O. they also contain secondary plant micronutrients Ca, Mg, S and micronutrients like Cu, Fe, Mn, Md, Zn, and B. in general, fertilizers can be categorized as organic fertilizers and chemical (or inorganic) fertilizers. Organic fertilizers are not used commercially due to lower productivity.

Effect of Chemical Fertilizers on Water Pollution



Water is the most essential component for human existence. The earth is called as 'Blue Planet' because of water which covers almost three fourth of earth's surface. Water is not only essential for survival of all living things but is also the source of economic wealth and the creator of beautiful environment. Chemical fertilizers contain phosphates, nitrates that can actually be the main reason behind water pollution. Nitrate leaching particularly linked to agricultural practices such as fertilizing and cultivation. Irrigated agricultural land in some of the arid and semiarid regions, increased amounts of nitrate accumulation in the soil used and along with the evaporation of water. According to the conditions, nitrate accumulated leached in varying amounts. It reaches the depth of soil. In the soil, fertilizers converted to nitrate through nitrification by microorganisms. Due to negatively charge of nitrate can reach ground water.

Effect of Chemical Fertilizers on Human Health



Fertilizers are a mixture of toxic chemicals which are absorbed into the plants, leading toxins to enter the food chain via vegetables and cereals and water creating health affects increase and spread rapidly-contaminated water may contain high level of nitrates and nitrites, causing hemoglobin disorders. Heavy metals such as Mercury, Lead, Cadmium and Uranium have been found in fertilizers, which can cause disturbances in the kidneys, lungs and liver and cause cancer. Over 29 popular fertilizers tested positive for 22 toxic heavy metals, including silver, nickel, selenium, thallium and vanadium, all directly linked to human health hazards. Ammonium Nitrate exposure causes other health problems such as eye and skin irritation, producing a burning sensation. Inhalation exposure can result in irritation of the nose, throat, and lungs. One can also experience nausea, vomiting, flushing of the face and neck, headache, nervousness, uncontrolled muscle movements, faintness and collapse. Potassium Chloride interferes with nerve impulses, and interrupts with virtually all bodily functions and mainly affects heart functioning. It can cause all kinds of gastric and stomach pains, dizziness, bloody diarrhea, convulsions, headaches, mental impairments, redness or itching of the skin of eyes.

Need to Use Organic Fertilizers

Organic fertilizers are fertilizers that are naturally produced and contain carbon (C). Fertilizers are materials that can be added to soil or plants, in order to provide nutrients and sustain growth. Typical organic fertilizers include mineral sources, all animal waste including meat processing, manure, slurry, and guano, plant based fertilizers, such as compost, and biosolids. There is also other a biotic non-chemical, fertilizer methods that meet the Principles of Organic Agriculture, which determines whether a fertilizer can be used for commercial organic agricultur

Conclusion

Today, use of fertilizers is seen as a necessary agricultural crop production, because soil restores nutrients. However, firstly soil analysis should be performed carefully. After then, fertilizer should be given to soil. The structure and chemical content of the soil should be identified and the most appropriate type of fertilizers should be selected. The most suitable method should be processed. Otherwise, the fertilizer should be noted that errors will result in the loss of both energy and finance. Fertilizing should be done in time, should not be inappropriate times. For example a heavy rainfall to the seasons, fertilization, and fertilizers water will mix with the surrounding soil by leaching. For this reason, fertilizer will be lost from soil, as well as pollution of surrounding water and therefore it will result in harmful. Use of excessive quantity of synthetic fertilizers is harmful for human health. High levels of nitrates and nitrites in chemical fertilizer may cause some diseases.

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IMPROVING DRYLAND AGRICULTURE

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India is a very vast country with a great diversity of natural endowments such as soils, climate, ecological regions, flora and fauna. When we review the growth in food grain production from the planned era of development, it is clear that Indian agriculture is progressively moving up in spite of troughs in food grain production in some years. This has been largely due to the massive application of science and technology in the field of agriculture jointly by the Government and our farmers. This has helped in the transformation of Indian agriculture from a subsistence farming into a commercial one leading to self. Sufficiency in food grain production. The growth trend indicates a good deal of improvement in our capacity to withstand the effect of the fluctuations of weather on food production.

Our agricultural growth has two dimensions-horizontal and vertical. During the early phase, efforts were made to enhance production by increasing the area under cultivation. It increased from 119 million hectares in 1950-51 to 143 million hectares in 1984-85. We can increase this area to 150 million hectares by the tum of the century.

The vertical growth in productivity was made possible through the use of improved seeds, increased use of irrigation water, chemical fertilizers, plant protection chemicals and efficient management of these resources. The net area under irrigation increased from about 21 million hectares in 1950,51 to 39 million hectares in 1980-81, and we expect to achieve a target of 87 million hectares by 2000 AD when the full potential is expected to be realized. The fertilizer nutrient consumption increased from a paltry 0.1 million tonnes in 1950-51 to 7.8 million tonnes in 1983-84.

Our future challenges are great. Our food grain requirement for a projected population of about a billion by the turn of the century has been estimated at 225 million tonnes. Our demands on other agricultural products and raw materials such as fibre, fodder, fuel and timber would be tremendous. Keeping these challenges in view, the Prime Minister has called for a critical review of our land-use policy and a substantial increase in agricultural production.

Dryland Agriculture

To realize the projected demands of food grains and the other items of basic need, productivity increase in agriculture should be achieved in both irrigated lands and drylands. I have no doubt that increasing focus on the irrigated command area development programmers in the coming years for efficient use of irrigation water and arresting water-logging and salinization will go a long way in increasing productivity from the irrigated areas and in providing a cushion against troughs in production.

The rainfed dryland areas lie mostly in the central and western parts of the country between latitudes 12^0 and 28^0North, bounded longitudinally by a line passing through Deher Dun and Hyderabad in the east and in the west by the national borders and the Western Ghats. Nearly all the districts in this region have less than 25% irrigated land and most have less than 10%. The mean annual rainfall varies from 350 to 1,400 mm and approximately the regions having low, medium and high rainfall constitute one-third each of the cultivated area.

At present, drylands contribute up to 45% of the cereals and 75% of the oilseeds and pulses to the total production in the country. Yet, the yields are very low and are characterized by wide seasonal fluctuations. Periodic droughts, flash floods, soil erosion, poor quality of drinking water, malnutrition, low income and unemployment are characteristic features of the drylands.

To provide the research back-up for increasing the productivity of crops from drylands and to improve the quality of life in the rural areas, the ICAR initiated in 1970 the All-India Co-ordinated Research Project for Dryland Agriculture with the assistance of the Canada International Development Agency.

The project primarily aimed at identifying the means to increasing and stabilizing crop production in the drylands of India. To achieve this goal, the following three objectives were set out:

1. To identify simple and easily implementable practices for increasing the productivity of drylands least by 100% in the farmers' fields.
2. To find out means to decrease the fluctuation in yield due to the vicissitudes of weather.
3. To conserve and optimize the rational use of natural resources, land and water (rainfall), at the farmer's level.

The research efforts by the project have already generated information on the first two objectives mentioned above. I am happy to note that the present emphasis is in refining the available crop production techniques and properly utilizing the natural resources and the improved technology on a watershed basis.

It is very satisfying to know that through the sustained research efforts of this project, the ICRISAT and other research institutions in the country, it has been demonstrated that the drylands are capable of producing 150 to 300% of the present level of production.

About 3,250 trials conducted by the Dryland Project on the farmers' fields during 1976-80 show that improved land management alone increased yield to the tune of 15%. The use of improved seed increased yield by 40% while moderate levels of fertilizers alone increased yields by 50%. But what is very important is synergism. A judicious combination of these three factors have indicated a 135% increase in yield over different seasons, crops and situations. Seed is a very important catalyst in programmer, and all-out efforts are being made by the Government to supply the needed seeds of high-yieiding varieties and hybrids to the farmers. A similar effort is also being made to promote fertilizer use in the dryland agriculture.

Dryland crops depend on rains for water. These lands are generally slopy and shallow and hold less water. Among the constraints that affect production in drylands, the important ones are (i) Environment, (ii) Resource management, (iii) Limitations of draft power, (iv) Transfer of technology, and (v) Availability of credit and marketing facilities.

(i) **Environment.** It broadly includes the climate and soil factors. Efficient crops and cropping systems have been identified by the project and its co-operating centres. Efficient intercropping and even double cropping systems are also identified for different agro-climatic regions in the country. These have been tested by researchers on real farm situations in association with the extension agencies and found very efficient. But in the real farm situations we have been witnessing changes in the crops and cropping patterns. About 8.7 lakhs of medium to shallow black soils sown earlier with sorghum have now come under sunflower in Maharashtra, Karnataka, Andhra Pradesh and Tamil Nadu. Another 10 lakh hectares of medium to black soils, particularly of Madhya Pradesh, have gone to soybean from either kharif fallows or crops like sorghum. New areas are coming under pigeon pea (red gram), replacing sorghum. Today, these changes constitute a small percentage of the total cropped areas. But over the years, it might become phenomenal. All this is happening more out of economic considerations and labour problems. While the Government would make efforts to provide incentive prices to coarse grains as well as to other dryland crops, the researchers should intensify their efforts to develop a technology to diversify farming and stabilize production. What is very important is to provide several alternatives to the farmer so that he can have a choice, keeping his various requirements in view, as well as the risk involved due to weather aberrations.

(ii) **Resource management.** Farmers in the dryland areas are very poor and cannot afford to make capital investment on soil and water conservation. Investigations of the Dryland Project indicate that with an investment of about Rs 4,000 to 5,000 per hectare some permanent improvements in land treatment and on-farm water harvesting can be made on a watershed basis.

In order to extend the benefits of the improved dry-farming technology on larger operational areas, the Union Ministry of Agriculture has identified 5,000 watersheds. Successful implementation of these programmes demands a cadre of professionals who can conceive, plan and implement the development of land and water resources in rainfed areas. The commitment of the State Governments and institutional agencies is equally important. The ICAR will provide the expertise to this programme and meet the training requirements by strengthening the Central Soil and Water Conservation Research and Training Institute and its regional stations. It is in this context I feel that the upgradation of this project as a Central Institute is timely.

In the Seventh Plan, the Government intends to provide through a Technological Mission better weather-forecasting service and management strategy in dry-farming districts, This would demand closer operational linkages between Indian Meteorology Department,

Department of Space, Department of Agriculture, Department of Rural Development, the ICAR and agricultural universities.

(iii) **Limitations of draft power.** In dry-farming areas there is a general constraint in the availability of adequate farm power, The average farm power availability in the country is estimated as 0.31 hp/ha from animal sources. Where mechanization has not spread, the availability of farm power is around 0.4 hp/ha. On the other hand the desired farm power requirement is estimated as I ph/ha. Since the dryland farmers have to depend mainly on human and bullock power, the wide gap in the requirement and availability is obvious. This factor is mainly responsible for the majority of the dryland farmers being not in a position to adopt timely sowing and placement of seed and fertilizer in the moist zone essential for optimum plant population and to ensure weed-fee crop stand through intercultural operations. The yield increase by adoption of these agronomic practices would be more than additive. The advantage of timely sowing alone has been estimated to the tune of 25% increase in yield.

In the regions where we have been able to achieve high production, the increase has been associated with the supplementation of traditional farm power sources with electro-mechanical sources like tractors, power tillers and electric motors, along with matching implements for critical operations. In the dry-farming areas, where farm operations have to be carried out in time under severe field conditions, still more efforts have to be made to supplement the farm power needs with electro-mechanical power sources. Since a vast majority of the farmers are small and marginal, they have to be served on custom hire-service basis. The State Department of Agriculture, Agro-Industries Corporation, Co-operatives and private agro-service centres have a great role to play in this direction.

(iv) **Transfer of technology.** Effective communication of the improved technology calls for an aggressive extension system. I am glad that the potentials of the improved technology are demonstrated by the scientists themselves, away from the research stations, in farmers' fields through National Demonstrations, Operational Research Projects and Lab-to-Land Programmes. The Teachers Training Centre and the Krishi Vigyan Kendras have to play a leading role in the dissemination of improved technologies to the extension functionaries and the farmers.

The Project work indicates that by training the farmers though the concept of 'learning while doing' there could by yield increases up to 100%, and still greater increases can be obtained with 'spot guidance' during the crop season. The Training and Visit Extension System will have to be geared for this task, particularly for meeting the training needs of small and marginal farmers.

(v) **Availability of credit and marketing facilities.** We cannot afford to leave our farmers resigned to the belief that once poor, ever poor. With adequate credit support, a vast majority of our frames could be economically uplifted with gainful employment prospects by adopting improved agricultural technology.

Conclusion

Although mobilization of credit to farmers has taken a fillip in the recent past, the institutional credit support to dryland farmers is far from adequate. The importance of this service through banking institutions and co-operatives need hardly be over-emphasized in the context of the poor resource base of the dryland farmer and the risk involved in dryland farming. Improve in credit support to the dryland farmers could be thought of by measures such as differential lending rates, conversion of short-term loans to medium-term loans in contingent situations, a mix of lending components in kind and cash for custom service, etc. In fact the whole structure of credit and input supply and marketing should be geared and reoriented to the best advantage of the poor dryland farmers so that they can soon usher in a green revolution in the brown drylands.

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GRASS-FED AND GREEN: THE POWER OF SUSTAINABLE GRAZING MANAGEMENT IN COMBATING CLIMATE CHANGE

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Livestock farming is one of the most significant producers to global greenhouse gas emissions, which have a substantial impact on climate change. Greenhouse gases such as carbon dioxide (CO2), methane (CH4), and nitrous oxide (N2O) trap heat in the atmosphere, causing the temperature of the Earth to increase. Multiple sources, including enteric fermentation, manure management, and feed production, contribute to greenhouse gas emissions from livestock farming. Methane is a strong greenhouse gas produced by enteric fermentation, which happens during digestion in the stomachs of ruminant animals such as cows and sheep. If manure management is not effectively handled, methane and nitrous oxide can be discharged into the atmosphere. Through the use of fertilisers, pesticides, and energy-intensive production processes, the production of feed crops for livestock farming also contributes to greenhouse gas emissions. Additionally, continuous grazing is less likely to negatively affect livestock productivity in forest ranges. (Virgilio di *et al.*, 2019)

According to the Food and Agriculture Organization of the United Nations (FAO), livestock farming contributes more to global greenhouse gas emissions than the whole transportation industry. In addition, the FAO anticipates that the worldwide demand for meat and dairy products will continue to rise, resulting in a rise in greenhouse gas emissions from the livestock sector. The impact of livestock production on climate change is not limited to emissions of greenhouse gases. In addition to contributing to carbon emissions, livestock production can also result in deforestation and soil deterioration. Additionally, animal farming can contribute to other environmental issues, such as water pollution and biodiversity loss.

Sustainable Grazing Management is a strategy that can aid in the reduction of greenhouse gas emissions from livestock agriculture. Grazing management involves the management of cattle movement to maximise fodder use and maintain a healthy vegetation cover.

What is Sustainable Grazing Management?

Sustainable Grazing Management (SGM) is essential for preventing land degradation, supporting food security and human well-being, and potentially mitigating and adapting to climate change. A controlled approach to cow roaming can enhance grassland soils, biodiversity, and carbon sequestration by regulating cattle movement, grazing time, and intensity. Sustainable Grazing Management is a collection of strategies and guiding concepts that aims to maximise the utilisation of grazing area for livestock farming while reducing its environmental impact. It entails controlling cattle movement to guarantee the sustainable use of natural resources such as water and vegetation, while also increasing soil health, biodiversity, and carbon sequestration. The components of Sustainable Grazing Management are the grazing system, grazed vegetation, grazing animal, herbage production and usage, plant composition and nutritional value, food conversion efficiency, sward conditions, herbage intake, and animal performance output from grazing systems (Scarnecchia & Hodgson, 1992).

Sustainable Grazing Management aims to ensure the long-term viability of grazing land and the economic viability of livestock production while reducing their environmental impact. Rotational grazing, intense grazing, and rest-rotation grazing are Sustainable Grazing Management strategies.

Benefits of Sustainable Grazing Management

Sustainable Grazing Management is essential for preventing land degradation, supporting food security and human well-being, and contributing to climate change adaptation and mitigation. (Díaz-Pereira *et al.*, 2020)

Benefits	Explanation
Improved soil health	Sustainable Grazing Management strategies, such as rotational grazing, can promote soil health by encouraging the establishment of diverse plants

	and reducing soil compaction, thereby increasing soil organic matter, enhancing soil structure, and enhancing nutrient cycling.
Increased carbon sequestration	Rotational grazing increases soil carbon sequestration, which reduces climate change by removing carbon di-oxide from the atmosphere.
Reduced greenhouse gas emissions	Rotational grazing reduces methane emissions from cattle digestion and waste management, reducing greenhouse gas emissions from livestock farming.
Increased biodiversity	Sustainable Grazing Management can stimulate the establishment of native grasses and other flora, which can provide habitats for a variety of wildlife and increase biodiversity.
Enhanced food security	Sustainable grazing management can increase livestock farming's grazing land availability and productivity, improving food security.
Reduced soil erosion	Sustainable grazing management can reduce sediment and nutrient runoff into streams by preserving healthy plant cover and limiting overgrazing.
Improved animal welfare	Sustainable grazing management reduces animal stress and provides a varied range of flora.
Economic benefits	Sustainable Grazing Management reduces feed and fertiliser costs and boosts grazing area productivity and resilience, making livestock production more profitable.
Water conservation	Sustainable grazing management promotes vegetation that holds soil moisture, reduces runoff and evaporation, and improves water infiltration.
Reduced need for chemical inputs	Sustainable grazing management promotes diversified flora and reduces weed control, minimising the need for herbicides and pesticides.
Reduced risk of disease transmission	Sustainable Grazing Management reduces livestock disease transmission by decreasing overcrowding, spreading manure, and lowering stress.
Improved aesthetics and recreation opportunities	Sustainable grazing management promotes diverse plants and enhances the landscape's aesthetic value. Hiking and birdwatching can benefit from this.
Improved social and cultural value	Sustainable Grazing Management strategies can help rural communities who depend on livestock farming preserve and develop their cultural heritage and traditional knowledge of grazing land management.

Barriers of Sustainable Grazing Management

Although Sustainable Grazing Management practises offer numerous advantages, there are obstacles to their implementation. Common obstacles include:

1. Lack of information and awareness: Many livestock farmers may be unaware of the benefits of Sustainable Grazing Management methods or lack the knowledge necessary to effectively adopt them.
2. Limited resources: Sustainable Grazing Management techniques may necessitate substantial infrastructure investments, including fencing, irrigation systems, and

animal handling facilities. The cost of applying these methods might be a substantial obstacle for many farmers.

3. Market demand: Some livestock farmers may believe that Sustainable Grazing Management practises are not valued on the market and, as a result, perceive no financial reason to adopt them.

4. Policy and regulatory barriers: Policy and regulatory hurdles might also impede the implementation of Sustainable Grazing Management techniques. Some government policies, for instance, may not provide incentives for Sustainable Grazing Management practises or may actively discourage them through regulations or subsidies that favour conventional agricultural practises.

5. Cultural and social factors: The application of Sustainable Grazing Management principles may also be hindered by cultural and social considerations. Some farmers may be resistant to change or believe that these activities are not in line with their principles or conventional farming methods.

6. Time constraints: Typically, Sustainable Grazing Management practises require more time and labour than conventional agricultural practises. This can be an obstacle for farmers who are already overburdened with other farm tasks.

7. Lack of access to markets: If farmers do not have access to markets that value Sustainable Grazing Management practises, they may be reluctant to use them. If there are no buyers prepared to pay a premium for grass-fed beef, for instance, farmers may not see a financial incentive to implement sustainable grazing practises.

8. Climate and environmental conditions: Depending on a region's climate and environmental factors, Sustainable Grazing Management approaches may or may not be suitable. In certain regions, the efficiency of Sustainable Grazing Management strategies may be hindered by factors such as water scarcity or soil erosion.

9. Limited research: There is still much to learn about the efficacy of Sustainable Grazing Management strategies and their optimal implementation. It might be difficult for farmers to determine which strategies will work best in their particular circumstances due to a lack of research.

10. Lack of infrastructure and support services: Finally, farmers may lack access to the necessary infrastructure and support services to effectively apply Sustainable Grazing Management practises. If there are no local veterinarians or extension agents with expertise in sustainable grazing management, for instance, farmers may not know where to turn for guidance or assistance.

Role of Policy and Market Initiatives in Promoting Sustainable Grazing Management

Policy and market incentives can play a critical role in promoting Sustainable Grazing Management practices in the livestock industry. Policy and market incentives can stimulate the adoption of sustainable grazing methods in the following ways:

1. Financial incentives: Governments may offer grants or subsidies for infrastructure expenditures such as fencing, water systems, and vegetation control in order to encourage farmers to follow Sustainable Grazing Management techniques. Financial incentives can assist cover the expenses of shifting to sustainable grazing techniques, thereby increasing the economic viability of these measures for farmers.

2. Certification programs: Certification programmes can assist farmers in gaining access to premium markets that value Sustainable Grazing Management techniques. For instance, the American Grassfed Association certifies grass-fed livestock products, enabling producers to receive higher pricing and enhance demand for their products.

3. Research and development funding: Governments can also contribute funds for Sustainable Grazing Management research and development. This can aid in the development of new technologies and strategies that can improve the effectiveness and efficiency of sustainable grazing methods, hence reducing costs and increasing acceptance.

4. Voluntary programs: Voluntary programs can also be effective in promoting Sustainable Grazing Management practices. For example, the Natural Resources Conservation Service (NRCS) offers the Conservation Stewardship Program, which provides technical and financial assistance to farmers who implement sustainable grazing practices on their land.

5. Regulation: Finally, Sustainable Grazing Management techniques may be promoted by regulation. For instance, governments can impose sustainable grazing practises on farms as a prerequisite for getting government subsidies or permits.

6. Market incentives can also play an important role in encouraging Sustainable Grazing Management. For instance, people are becoming increasingly interested in sustainably produced food, and businesses are reacting to this demand by offering items made utilising sustainable grazing techniques. As more people seek sustainably produced food, the market demand for Sustainable Grazing Management strategies is projected to expand, giving producers with greater incentives to embrace these methods.

Importance of Stakeholder Engagement and Collaboration

The successful adoption of Sustainable Grazing Management practises in the cattle industry is contingent on the participation and collaboration of stakeholders. With appropriate management, ruminant livestock can play a significant role in reversing environmental damages caused by human mismanagement and neglect (Teague & Kreuter, 2020).

a) Shared responsibility: Multiple stakeholders, including farmers, ranchers, conservation groups, policymakers, and researchers, must coordinate their efforts for sustainable grazing management. Each stakeholder has a distinct role to play in promoting sustainable grazing practises, and teamwork is necessary to ensure that all parties are working toward the same objective.

b) Diverse perspectives: Engagement of stakeholders brings together varied viewpoints and expertise, which can assist in identifying and addressing potential hurdles to the adoption of sustainable grazing techniques. By engaging with stakeholders, policymakers and researchers can better comprehend the needs and challenges of farmers and ranchers and develop solutions that are practical, effective, and economically viable.

c) Improved outcomes: When stakeholders work together, they can generate more effective and complete solutions to complicated challenges. By combining knowledge from a variety of disciplines, stakeholders can develop new strategies to improve soil health, reduce greenhouse gas emissions, and boost cattle industry production.

d) Increased buy-in: Engagement of stakeholders can also aid in gaining support for Sustainable Grazing Management techniques. By include farmers, ranchers, and other stakeholders in the decision-making process, they will be more invested in the success of sustainable grazing methods and more likely to implement them on their own operations.

e) Scaling up: Collaboration and stakeholder participation are vital for scaling up Sustainable Grazing Management methods. By collaborating, stakeholders can develop strategies for promoting sustainable grazing practises at the regional or national level, ensuring that these practises are adopted more broadly and have a bigger influence on the livestock industry as a whole.

Conclusion

Sustainable Grazing Management methods have the ability to reduce greenhouse gas emissions from livestock agriculture while enhancing soil health, plant development, and carbon sequestration. However, there are obstacles to implementing these practises, such as a lack of knowledge and access to resources, as well as policies and market incentives that do not support sustainable grazing methods. Future research and policy development should focus on identifying effective incentives for farmers and ranchers, promoting collaboration and communication between stakeholders, monitoring and evaluating the effectiveness of these practises, and understanding the potential impacts of climate change on the livestock industry in order to promote the adoption of Sustainable Grazing Management practises. By collaborating and adopting Sustainable Grazing Management techniques, we can create a healthier ecosystem, a more resilient earth for future generations, and a more sustainable cattle economy.

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