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Farmers' Welfare  
Farm Information Bureau



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# KERALA KARSHAKAN

*English journal*

The First English farm journal from the house of Kerala Karshakan

Analyzing the  
value addition of

## Corn silk

as an employment  
generating  
initiative



## The First English farm journal from the house of Kerala Karshakan

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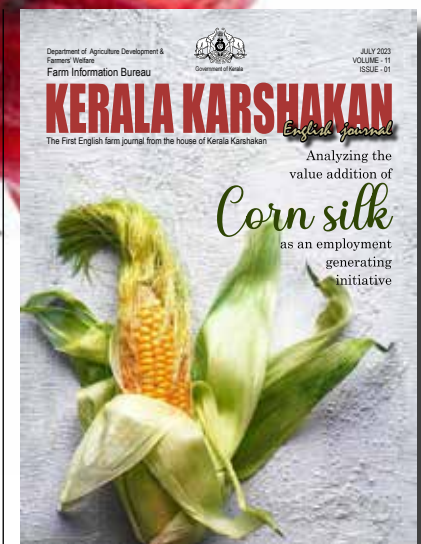
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# ROSELLE

## A MIRACLE HERB



### Abstract

#### Introduction

Roselle (*Hibiscus sabdariffa* L.) obtained a global fame for its multipurpose benefits and is estimated to have more than 300 species all over the world. It is a tetraploid ( $2n = 4x = 72$ ) annual herb, belonging to Malvaceae family which is cultivated extensively in tropical and subtropical regions (Ibrahim et al., 2013). Roselle is a versatile underutilised crop which has great promise for both industrial and medical applications. Significant amounts of biologically active substances, including anthocyanins, flavonoids, vitamins and polyphenolic acids are present in roselle, a class of foods called as functional foods that offer advantages over conventional nutrition for human health.

Roselle is primarily grown for its calyx, which comes in red, green and dark red varieties. The leaves of green types are eaten as vegetables, while the calyx of red and dark crimson varieties is used to extract juice for a fresh drink after being sweetened. Each part of the roselle plant, including the leaves, fruits, roots and seeds is used in various dishes.

Due to its diverse range of bioactive ingredients, vibrant colour and strong scent content, the dried calyx of the roselle is used in the creation of a variety of foods and beverages. The fragrant extracts from roselle have been shown to include more than 200 fragrance components. These substances have a significant impact on customer acceptability and preference, making them a key roselle quality indicator.

The economic potential of roselle as a natural food colouring ingredient has piqued the interest of food, beverage, and pharmaceutical industries (Eslaminejad and Zakaria



*Top view of the calyxes*

2011). The calyxes may be utilised to make wholesome and nutrient-dense food compositions since they are a rich source of phytochemicals and antioxidants.

In addition, Roselle sells a variety of processed food items that have been fruit-blended viz., beverages, jellies, sauces, liqueurs, preserves and wines by utilising the dried calyxes. Roselle is used to make a variety of products, including tea, powder, tablets, juice, extracts, jam and seed oil. Since Roselle

is a seasonal crop, it requires special handling to extend its shelf life through the adoption of a variety of processing methods, including drying, storage, and manufacturing of new kinds of food products.

### **Economic parts**

#### **Leaf**

- Leaves are dark green, some with red pigments.
- Roselle juice extracted from leaves is used to treat conjunctivitis and, when pulverized, soothes sores and ulcers.

- *Leaves can be used in salads, as a potherb and as a seasoning in curries.*
- *The leaves are extensively used as animal fodder.*





*Roselle extract from leaves is used to treat conjunctivitis and, when pulverized, soothes sores and ulcers*

- Leaf extracts are used in pharmaceutical companies.
- Leaves are used to make pickle which is very famous in Andhra Pradesh.

### Flower

- The flowers are light yellow to pink, red, orange, and purple red
- Calyx of its flowers which has a sour taste and is commonly used in the preparation of cold and hot beverages and as a food colorant
- Another consideration is the roselle's aesthetic appeal as a garden plant or cut flower. Exports of the ornamental red stems and mature red fruits are utilised in floral arrangements across



**Table 1. Nutritional composition of 100 g fresh roselle calyces, leaves and seeds**

Constituents	Fresh Calyces	Fresh Leaves	Seeds
Moisture	9.20 g	85.60 g	8.2 g
Protein	1.15 g	3.30 g	19.6 g
Fat	2.61 g	0.30 g	16.0 g
Fiber	12.00 g	10.00g	11.0 g
Energy	44 kcal	43 kcal	411 kcal
Ash	6.90 g	1.00 g	7.00g
Calcium	12.63 mg	213.00 mg	356 mg
Phosphorus	273.20 mg	93.00 mg	462 mg
Iron	8.98 mg	4.80 mg	4.2 mg
Carotene	0.03 mg	4135 µg	-
Thiamine	0.12 mg	0.2 mg	0.1 mg
Riboflavin	0.28 mg	0.45 mg	0.15 mg
Niacin	3.77 mg	1.2 mg	1.4 mg
Ascorbic Acid	6.70 mg	54 mg	trace
Carbohydrates	10.00 g	9.20 g	51.3 g

**Sources: Leung et al. (1968); Duke and Atchley (1984); Morton (1987); Morton and Dowling (1987)**

European countries.

### Fruit

- Roselle calyces are ideal ingredients for wine, syrup, ice cream, pies, snakes, tarts, and other sweets because of their vivid crimson colour, exceptional flavour, and other organoleptic qualities.
- It is used as natural dye in food industries.
- The fresh calyx (the outer whorl of the flower) is cooked, is eaten raw in salads, and used as a flavour agent in cakes.
- The calyx is also used in making soups, pickles, jellies, sauces, and puddings.
- Major source of pectin and citric acid which is utilised in making jams and jellies.
- Used for flavoring herbal teas
- The calyx can be boiled with a little bit of ginger and sugar

to make a cooling refreshing beverage.

- They contain a high amount of calcium, fibre, and iron, so the roselle calyces are frequently utilised in bakery and confectionary industries.

### Seed

- The seeds are kidney shaped with light brown in colour.
- Roselle seeds are used to produce biodiesel and also used as animal feed as the seeds contain 17.8 to

21% nonedible oil and 20% protein.

- Good source of protein, fat, and total sugars and is widely used in the diet in many African countries.
- The dry seed can be ground into a powder and used in oily soups and sauces.
- The oven-dried seeds have been used as a coffee substitute since it has aphrodisiac properties.

- *Roselle calyx tea (Krachiapdaeng in Thai) has been added to the Thai National List of Essential Medicines.*
- *Rich in Vitamin C*
- *Used as herbal tea to treat pyrexia, hypertension, and liver damage*





*Roselle tablets have been developed for patients with hypertension and diabetes and supplements for vitamin C*

- Prevents colorectal cancer
- Hibiscus acid [hibiscus type (2S, 3R)-hydroxycitric acid lactone] has the potency to inhibit intestinal  $\alpha$ -glucosidase and pancreatic  $\alpha$ -amylase activities

*Roselle juice rich in Vitamin C, Beta-carotene and Vitamins B1, B2, B6.*

### Nutritional value of roselle

High levels of vitamin C and anthocyanins are present in roselle. They are rich in calcium, K, Mg, N, Niacin, Riboflavin, and Iron.

### Roselle Plant Health Benefits

#### 1. Menstrual Pain

- Provides relief from cramps and menstrual pain
- Helps in restoring hormonal balance

#### 2. Anti-Inflammatory and Antibacterial Properties

- Fresh or dried flower of roselle contains high quantities of

Vitamin C. Vitamin C is an essential nutrient required by our body to boost and stimulate the activity of our immune system

- Boosts immune system preventing cold and flu
- Anti-inflammatory and antibacterial properties
- Manage obesity and prevents ageing
- Due to its cooling effect, it helps to treat discomfort caused by fever

#### 3. Aids Digestion

- The seed capsule in the Roselle fruit is known for its diuretic and tonic properties. It is hence used for the following purposes:
- Due to its diuretic properties, it increases both urination and bowel movements
- Treats constipation



*Roselle jam*



- *Gongura pickle - the whole flavor of Andhra meal*
- *Leaves are utilised for pickle making*
- *Good source of carbohydrates, fiber and proteins, vitamins, and minerals*



#### 4. Weight Loss

- Roselle extracts lowers the absorption of starch and glucose and may help with weight loss and found in many weight loss products.

#### 5. Antidepressant Properties

- Contains antidepressant properties like flavonoids
- Helps to calm down the nervous system
- Helps to reduce anxiety and depression by creating a relaxed sensation in the body and mind.

#### 6. Anti-Cancer Properties

- Hibiscus protocatechuic acid, which possesses anti-tumor and antioxidant effects, is a component in Roselle herbal tea.

- According to a study done at the Chung Shan Medical and Dental College in Taichung, Taiwan's Department and Institute of Biochemistry, hibiscus inhibits the development of malignant cells by causing apoptosis, also known as programmed cell death.

#### 7. Cough, Colds and Fever Management

- According to the book "Healing Herbal Teas," fresh roselle contain about 6.7 mg of ascorbic acid, vitamin C, which is one of the most crucial elements for the body metabolism.
- It is frequently used as a

*Sudanese "Karkade", a cold drink made by soaking the dried roselle calyces in cold water overnight in a refrigerator with sugar and lemon.*

supplement to help cure coughs and colds owing to its cooling impact because it is believed to have anti-inflammatory and moderate antibacterial effects.

- Traditionally in Africa, Roselle leaves are used for their, emollient, antimicrobial, antipyretic, sedative properties, diuretic, antihelminthic, and as a soothing cough remedy

*Roselle seed used as a coffee substitute*





*Honey enriched with roselle*



*Roselle fruit juice*

**8. Blood Pressure Management**

- According to AHA (American Heart Association) report, November 2008 it is illustrated that consuming hibiscus tea lowers the blood

pressure in pre-hypertensive and mildly hypertensive adults.

- Odigie IP suggests that it has anti-hypertensive and cardio-protective properties that can be beneficial to people suffering from hypertension and those at high risks of various cardiovascular diseases.
- According to research done at Tufts University in Boston, consuming three cups every day for a few weeks, reduces blood pressure by up to 10 points.



*Roselle powder used in cosmetics and food colour industries*

**9. Protects Liver**

- Antioxidant properties helps to treat liver diseases because they neutralize the free radicals present in body tissues and cells.
- Mild laxative effect, ability to increase urination, provide relief during hot weather,



*Roselle bath salt*

and for treatment of cracks in the feet, sores, bilious, and wounds

**10. Maintains Healthy Teeth and Gums**

- High calcium content helps to fortify teeth and can protect

tooth enamel.

## 11. Healthy Pregnancy

- Due to the high iron concentration in roselle, it is very beneficial during pregnancy.

### Conclusion

The Roselle crop is valued for its versatile bast fibre and is regarded as a significant exportable product. It has been used as an herbal medicine in phytotherapy and nutritious vegetable. In summary, Roselle is a potential crop which is very well suited to tropical and subtropical areas, which can bring a vast benefit to the farmers and contributing positive impact to the food, pharmaceutical and cosmetic industries.

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*Roselle eye gel pack*



*Roselle dried calyxes*



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*Can we target  
Increasing  
milk production  
minimizing  
environmental  
impact ?*

A recent press release posted on 07 FEB 2023 by Ministry of Fisheries, Animal Husbandry and Dairying states "According to production data of Food and Agriculture Organization Corporate Statistical Database (FAOSTAT), India is the highest milk producer i.e., rank first position in the world contributing twenty-four percent of global milk production in the year 2021-22. The milk production of India has registered fifty-one percent increase during the last eight years i.e., during the year 2014-

### Some facts (FAO)

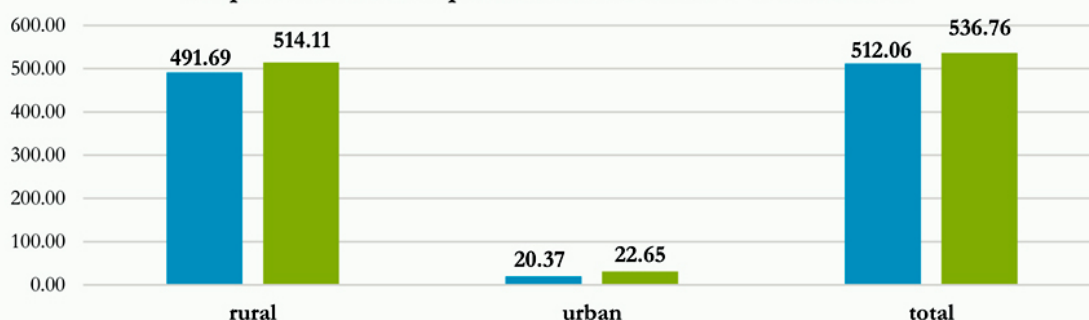
- Approximately 150 million households around the globe are engaged in milk production.
- An estimated 80 to 90 percent of milk in developing countries is produced in small-scale farming systems.
- More than 6 billion people worldwide consume milk and milk products; the majority of these people live in developing countries.
- Since the early 1960s, per capita milk consumption in developing countries has increased almost twofold.

15 and 2021-22 and increased to twenty-two crore tonnes in the year 2021-22” The population growth in the world is expected to be 9.6 billion by 2050. To ensure the good quality food in sufficient quantity and to ensure the health of the population is a big challenge. In the current trend, the food production may have to enhance by 70 percentage to meet the needs by 2050. At the same time, we must be cautious enough to reduce the bad effects of carbon footprint. That is, we must focus on increasing the production with minimum negative impact on environment targeting to end hunger, food insecurity and malnutrition.



### Livestock Census 2019

Graph 3: Livestock Population Rural & Urban - 2012 and 2019



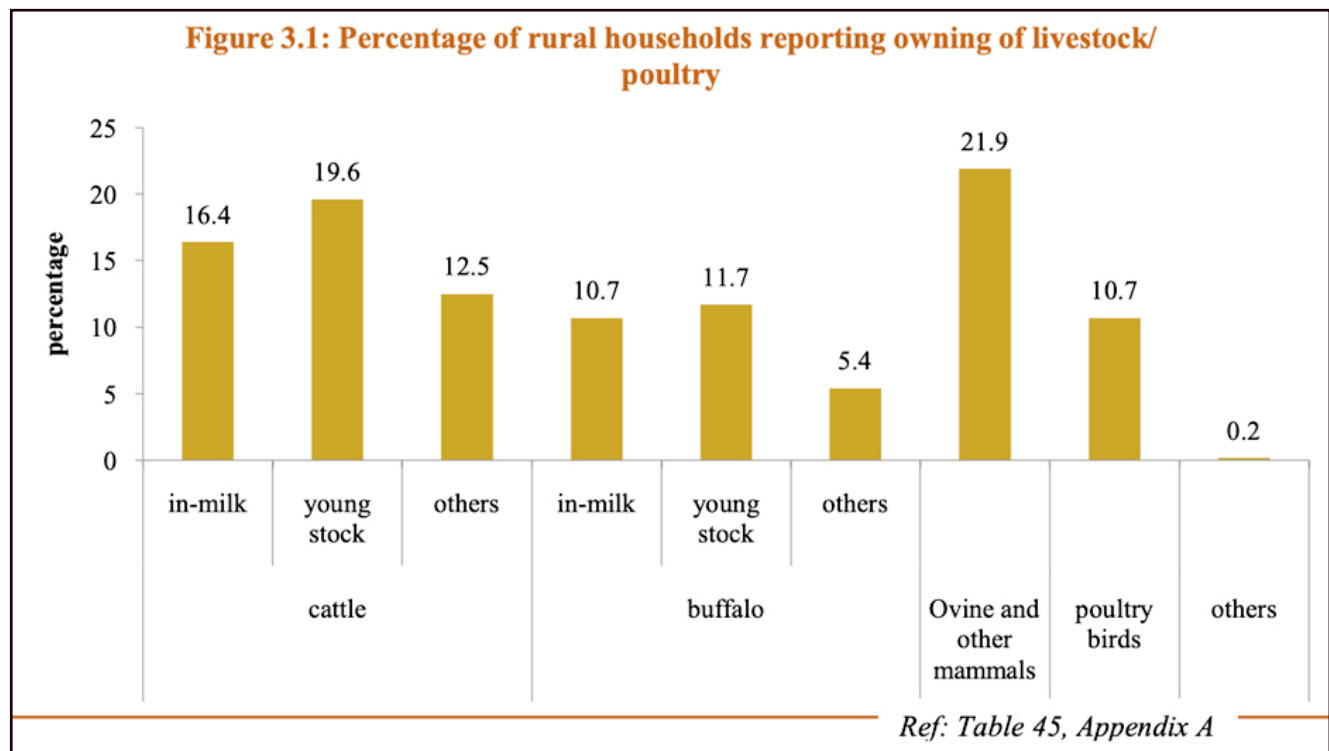


Dairy sector is a major employment providing and livelihood supporting sector, in addition to the role that it plays in ensuring food security, nutrition and public health. In the recent years a lot of changes have occurred in the milk production systems and in the consumption patterns. Today, India ranks first among countries not only in milk production, also in cattle wealth.

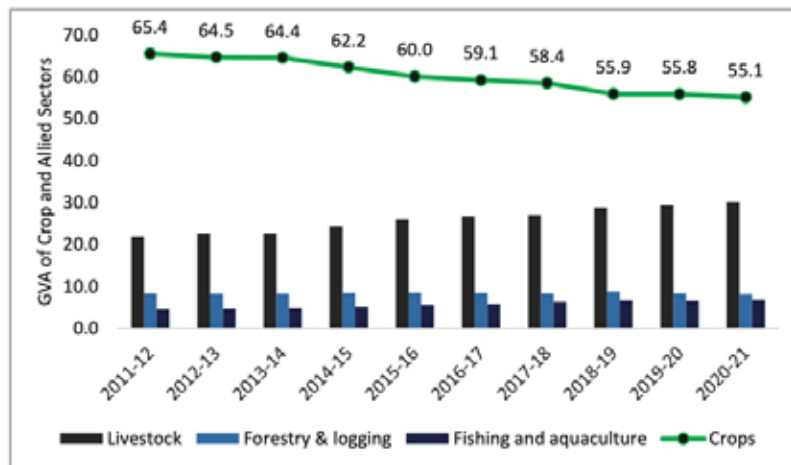
Regarding per capita availability of milk we are having much higher rate than the worldly average. At the same time, we are being accused by many major players in the world as the main contributor of global warming due to the greenhouse gas effect produced by the dairy sector mainly attributed to the low yield of animals. If the yield of cow can be improved the bad

effects on the environment can be controlled or reduced without hindering total milk production to meet the rising consumer demand. Increasing the yield of animals will reduce the emissions per kg output (Fat protein corrected milk- FPCM). Selection of potentially good animals and culling of unproductive is also very important. In this article it is being tried to give a

**NSS Report No. 587: Situation Assessment of Agricultural Households and Land and Livestock Holdings of Households in Rural India, 2019**



**Figure VIII.7: Though the Crop sector is still the major contributor to agriculture GVA, the livestock sector is catching up (per cent)**



Source: Based on data of MoSPI.

brief description of the current scenario of milch animals in our country taking into consideration the facts and myths. I.e. A bird’s eye view of the status of livestock sector as a major livelihood support in rural India, milk production and consumption trends, major milk producing species, contribution of buffaloes in milk production, potentially productive female cattle, average milk yield, greenhouse gas emission etc. Available data from Central Government (India) and Food and Agricultural organization (FAO) are used as base for analysis.

**Livestock a main Livelihood support sector in Rural India**

Agriculture, with its allied sectors, is the largest source of livelihoods in India. 70 percent of its rural households still depend primarily on agriculture

for their livelihood, with 82 percent of farmers being small and marginal. (FAO). Unlike leading milk producing countries in the world, large proportion (95 per cent) of milk producers in our country hold 1 to 5 animals per household. Latest census reports (2019) also supports this as it clearly shows more than 95% of livestock of the country is reared in rural India (514.11million out of 536.76 million). Approximately, 46 percent of the milk produced is consumed either at the producer level or sold to consumers in rural areas.

As per 77<sup>th</sup> round NSS report of national statistics office, 54 % of rural households are agriculture households. 2.3 % of agricultural households and 0.6% of non-agricultural households are engaged in livestock farming as self-employment. 16.4% of

house holds are reported to own cattle in-milk and 10.7% households own buffaloes in-milk.

NSS Report No. 587: Situation Assessment of Agricultural Households and Land and Livestock Holdings of Households in Rural India, 2019 Livestock sector is catching up in India

Economic survey reports states “the livestock sector grew at a CAGR of 7.9 per cent during 2014-15 to 2020- 21 (at constant prices), and its contribution to total agriculture GVA (at constant prices) has increased from 24.3 per cent in 2014-15 to 30.1 per cent in 2020-21”. It also states, “The dairy sector is the most critical component of the livestock sector, employing more than eight crore farmers directly, and is the most prominent agrarian



product.”

### Milk production and Consumption trends show increase

More than 600 crores of people (80%) all over the world consumes milk and milk products. It is a preferred choice of both vegetarians and non vegetarians. Compared to 1960, consumption of milk and milk products are doubled in developed countries. When we consider the worldwide data on milk production during the past 30 years from 1989 to 2019, an increase of 64 % is recorded. That is an increase from 538 million tones (1989) to 883 millionTones (2019). At

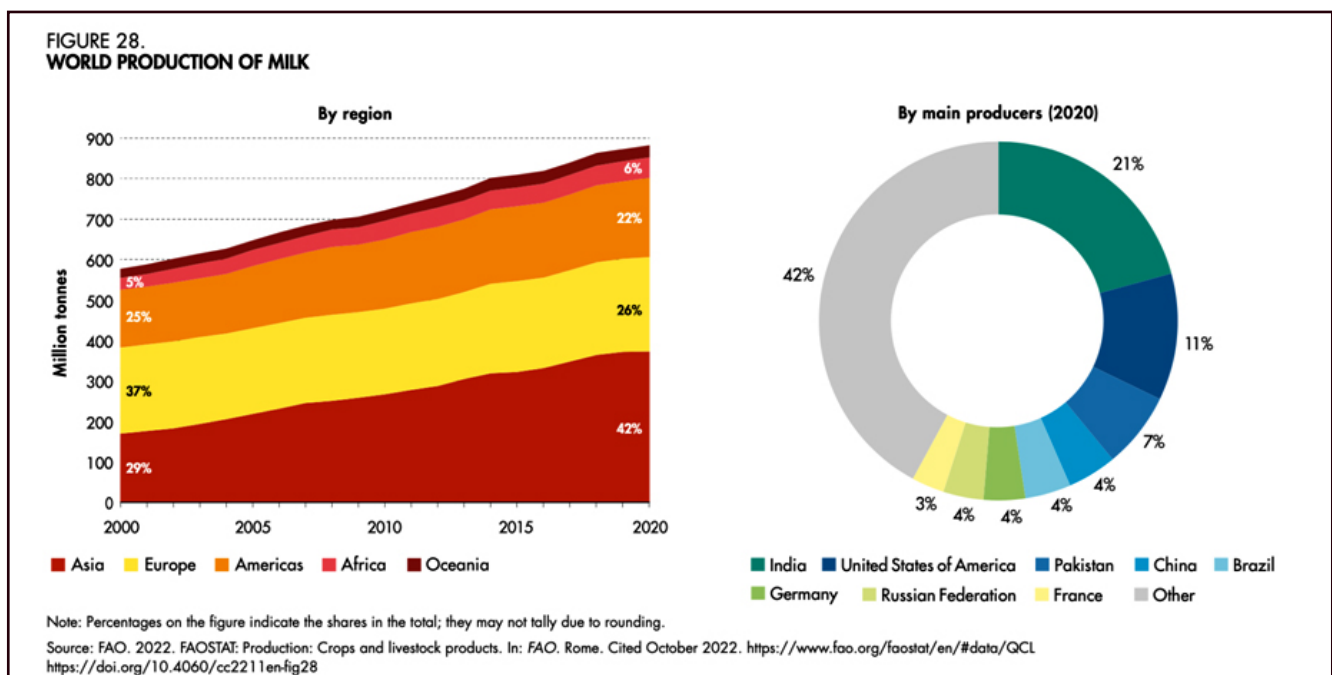
FAOSTAT 2022

the same time there is more than 250% (from 104 million tonnes to 369 million tonnes) increase in milk production in Asia during the period. The growth rate is very slow in Africa which can be attributed to the poverty and adverse climatic conditions. Countries like New Zealand, the United States of America, Germany, France, Australia and Ireland produce more than what is needed while countries like China, Italy, the Russian Federation, Mexico, Algeria and Indonesia are facing deficits. (FAO)

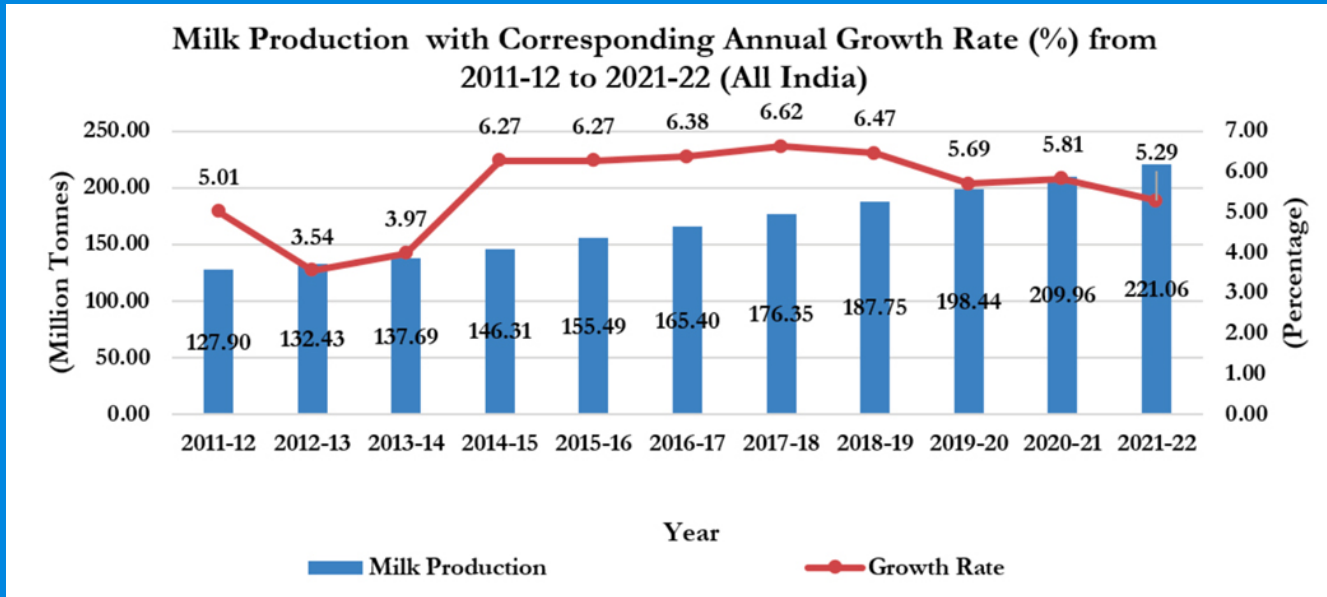
### India Ranks Number One in milk production

Milk production in Asia

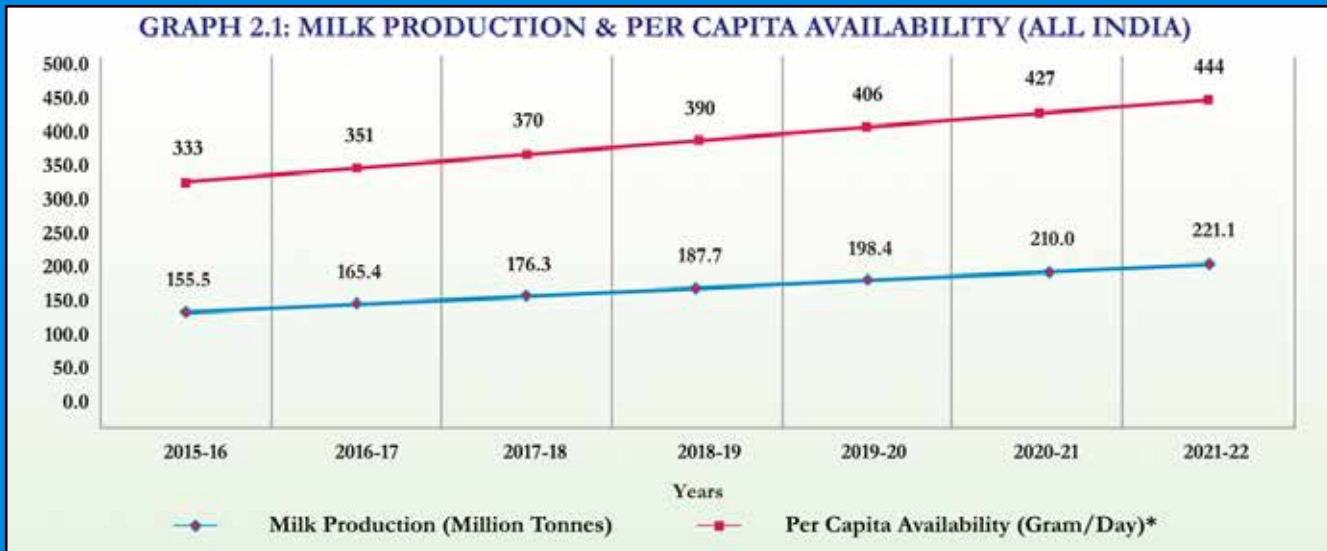
went up 120 percent between 2000 and 2020, from 170 million tonnes to 374 million tonnes mostly due to the increase in India (104 million tonnes), which was the largest producer contributing a 21 percent share to the global total in 2020. (FAO STAT 2022). There is a lot of difference in the production of milk among countries. Nearly 62 % of milk produced all over the world is accounted by nearly 10 countries and the first among them being India with a contribution of 21 % of total production. Among the other major contributors, USA providing 11 %, Pakistan 6%, Germany, Russia, China and







Basic Animal Husbandry Statistics\_ 2022



Brazil contributing 4% each.

It is stated in the 22-23 annual report of DAHD that India continues to rank first in milk production in the world and milk production increased by 5.29% compared to the previous year due the impact of strategies taken to increase milk productivity. It is to be noted that even though the annual growth rate declined by 0.52%

compared to the previous year (in 20-21 the annual growth rate was 5.81%) the total milk production increased from 209.96 million tonnes (20-21) to 221.06 million tonnes (21-22). During the past decade India is having appreciable growth in milk production (from 127.09 in 11-12 to 221.06 in 21-22).

**Milk availability Increased**

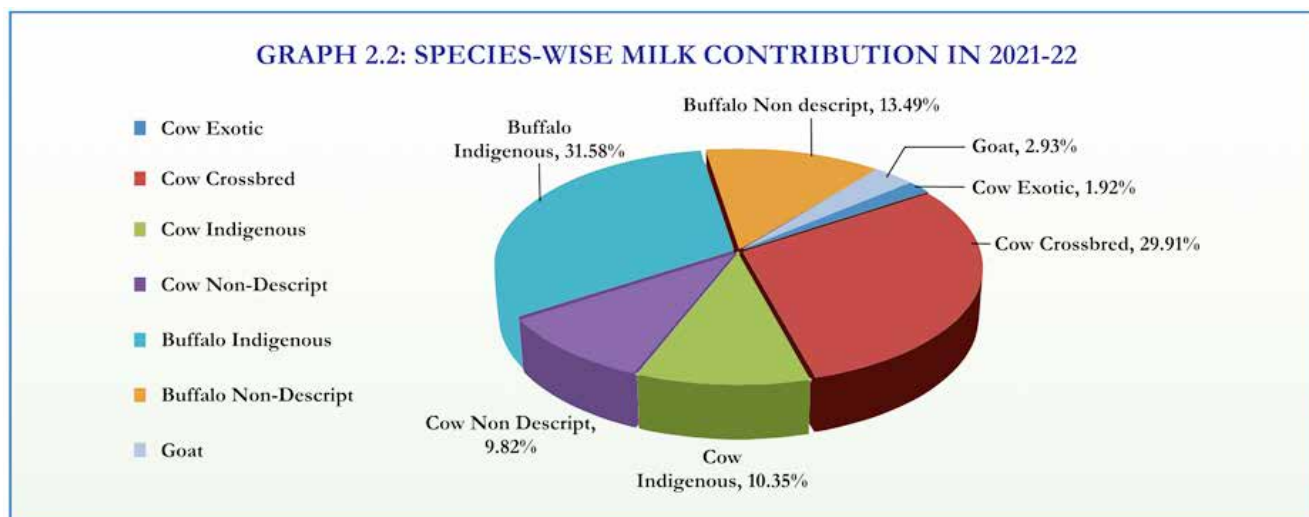
Coming to consumption,

the per capita milk availability in India raised from 427 gram per day (20-21) to 444 gram per day (21-22). The per capita availability of milk was at 130 gm/day in 1950-51. The estimated world average of 2021 for per capita milk availability is only 320 grams per day. I.e. our nation’s average is much higher than world average. As per FAO, per capita milk supply is

## Basic Animal Husbandry statistics 2022\_India

Total milk production	221.06 million tonnes
Annual growth rate in 2020-21	5.29%
The per-capita availability(PCA) of milk	444 gram/day
Rate of increase of PCA of milk(gram/day) over previous year.	17

## Basic Animal Husbandry Statistics \_BAHS2022



medium in India. "Per capita milk supply is medium (30 to 150 kg/capita/year) in India, Japan, Kenya, Mexico, New Zealand, Pakistan, North and Southern Africa, most of the Near East and most of Latin America and the Caribbean" (FAO)

It is also interesting to note that FAO food outlook 2022 (November) forecasted slowest growth pace for the world milk production in 2022(930 million tonnes) which may be up by 0.6 % than 2021. Much

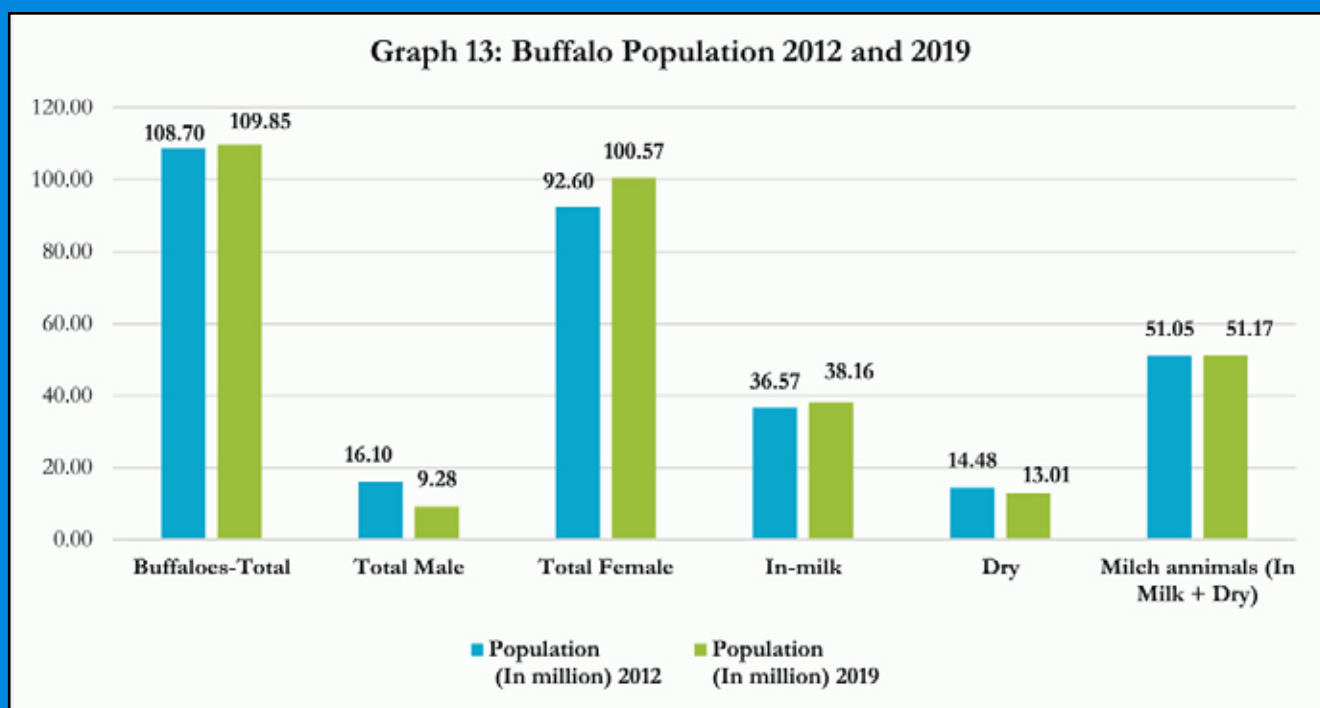
of the expansion was foreseen in India and Pakistan, but with a slower growth due to disease outbreaks and extreme weather conditions.

### India ranks number one in cattle wealth.

India counts number one in cattle wealth in the world with 193.461 million animals including 51.356 million exotic/cross breeds and 142.106 million indigenous animals. As per the 20<sup>th</sup> Livestock Census, 36.04% of the livestock population in India

belong to cattle. 52% of total cattle come under non-descript, meaning does not fall under the 41 descript indigenous breeds, as categorised by NBAGR or fall under an exotic and cross breed category. 22% of total cattle population are descript indigenous breeds and the remaining (26%) are exotic/cross breeds i.e. 45.4 million cross breeds and 5.7 million exotic breeds. Animals which have their origin in other countries (Exotic/ Cross breed) mainly Jersey and

## Livestock Census 2019\_Milch Buffaloes



## Livestock Census 2019\_ potentially productive female buffaloes

S.No.	Category	19 <sup>th</sup> Census 2012 (In million)	20 <sup>th</sup> Census 2019 (In million)	% Change
i)	Under 1 year	20.16	24.48	21.5
ii)	1 to 3 years	15.86	21.01	32.5
iii)	Over 3 years(excluding others)	55.59	53.99	-2.9
iv)	Others	0.99	1.08	8.9
v)	Total female buffalo	92.60	100.57	8.6
vi)	<b>Total no. of potentially productive female buffalo (v-iv)</b>	<b>91.60</b>	<b>99.49</b>	<b>8.6</b>

Holstein Friesian (HF) are the high producing animals as we know. Animals produced by crossing indigenous breeds with exotic or those indigenous animals having an exotic inheritance are called cross breeds. Also it should be noted that only 29.5% (41.879 million) of indigenous cattle fall under any of the breed as specified by NBAGR, and the remaining 70.5% (100.226

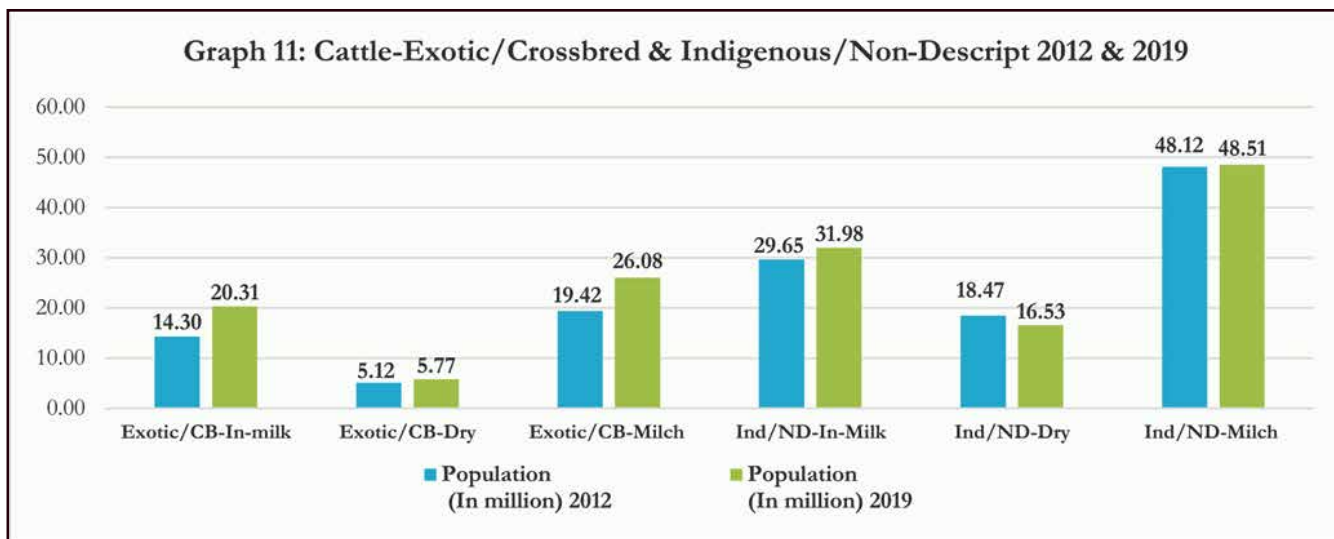
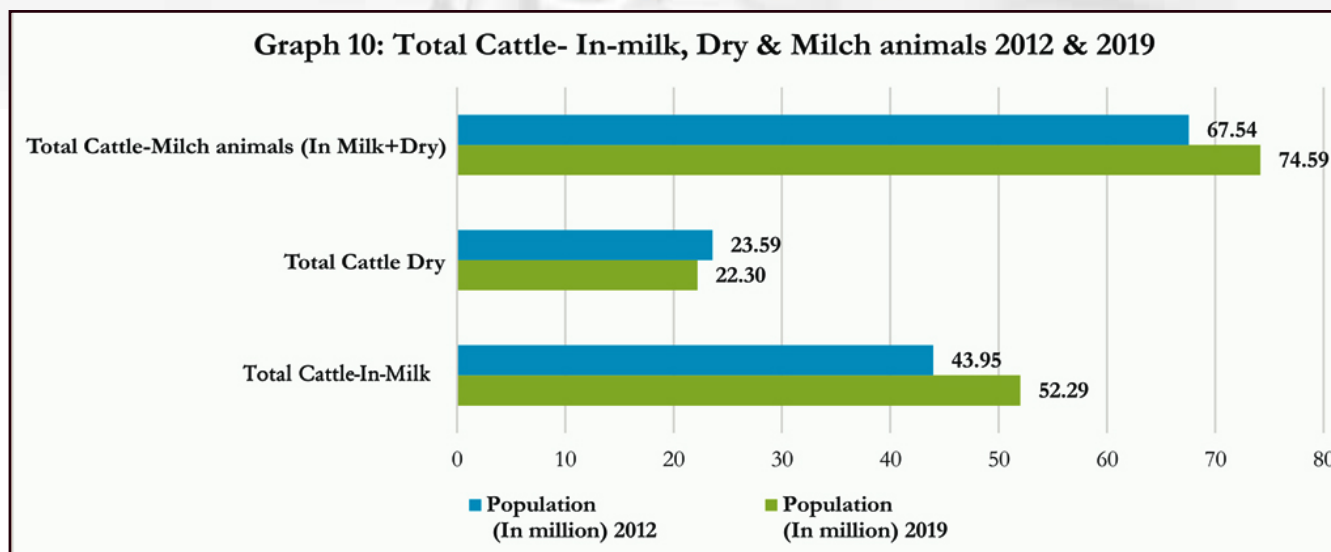
million) of indigenous cattle are non- descript.

### Major milk producing species in India:

Basic Animal Husbandry Statistics 2022 shows a clear picture of species wise milk contribution in 2021-22. 31.58% share of total milk production in India, is from indigenous buffaloes, 13.49% from non-descript buffaloes, 10.35% from

indigenous cows and 9.82% from non-descript cows. That is when buffaloes contribute 45% of the total milk production of the country and 52% is from cows. Only 31% of the milk is contributed by cross bred/exotic cows. Also, more than 20% of milk is from indigenous breeds and non- descript cows. Goats contribute only <3% to the national milk pool.

## Livestock census 2019



### Buffaloes, a major contributor of Milk production in India

Out of 204 million population of buffaloes (2020) in the world 109.852million (>50%) is in India. 20.5% of total Indian livestock wealth is of buffaloes & 31.58 % share of total milk production in India,

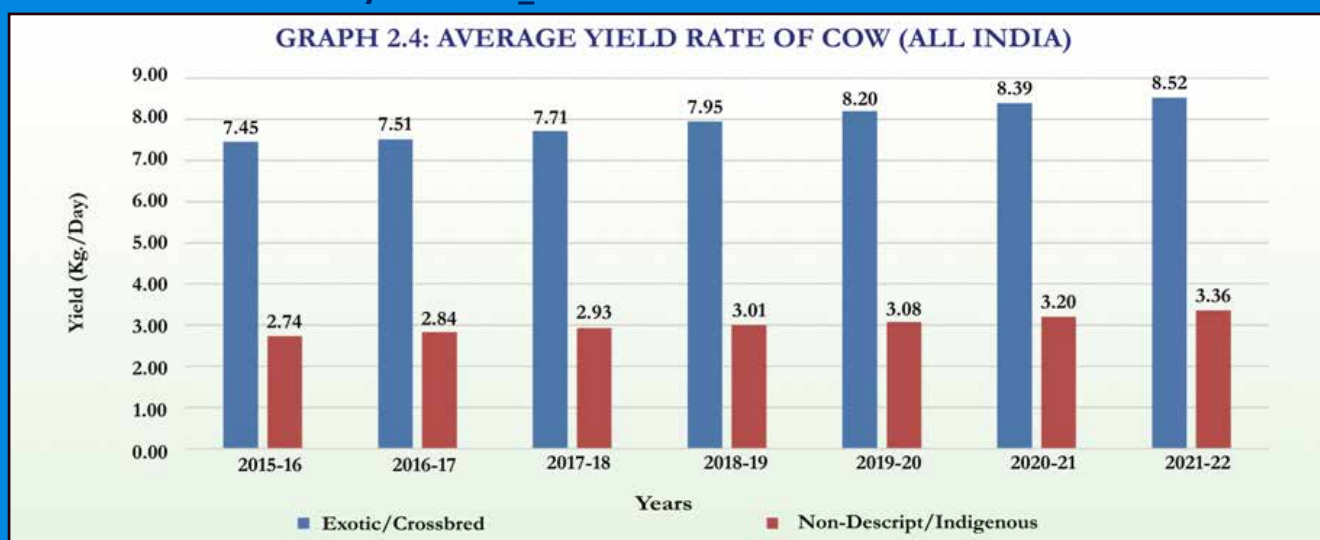
is from indigenous buffaloes. ie. 38.16 million in- milk buffaloes. Out of 100.569 million female buffaloes, 99.49 million is productive and 51.17 million are milch animals. Only 50 % of total female buffalo population are milch animals (46% of total buffalo population) and

only 38% of total females are in- milk. 99.626 million tonnes is their annual milk production contribution. Thus, buffaloes play an important role in milk production in the country. Also, it is important to note that the average milk yield rate of indigenous buffaloes is 6.6

## Livestock census 2019\_potentially productive female cattle

S.No.	Category	19 <sup>th</sup> Census-2012 (In million)	20 <sup>th</sup> Census-2019 (In million)	% Change- from 2012 to 2019
i)	Under 1 year	25.07	35.77	42.7
ii)	1 to 2.5/ 3 years	21.23	28.74	35.4
iii)	Over 2.5 (Exotic)/3 years(Indigenous) [excluding others]	75.14	79.39	5.7
iv)	Others	1.54	2.00	29.7
v)	Total female cattle (i+ii+iii+iv)	122.98	145.91	18.6
vi)	Total no. of potentially productive female cattle (v-iv)	121.44	143.91	18.5

## Basic animal Husbandry Statistics\_2022



kg per day while that of cross breed cow is 8.32 kg per day. Compared to indigenous cow having an average of 4.07 kg per day indigenous buffaloes yield much higher.

### Potentially productive female cattle

As per Livestock Census reports, out of 193.46 million cattle 145.91 million are female. Out of 51.356 million cross breeds/exotic 47.746 and out of 142.106 million indigenous

98.165 million are also females. Out of 143.91 million productive female cattle, 74.59 million is the total milch cattle including in-milch animals and dry animals as per the census data. Out of this milch category 26.08 million is exotic/cross bred, while 48.51 million is indigenous(descript & non-descript). Even though the milch cattle of exotic/cross bred cattle has increased by 34.3 % over the previous census data, still indigenous animals play an

important role in milk production. 143.91 million female heads are potentially productive. An increase of 18.5% compared to previous census data.

It is important to note that out of 193.46 million cattle (145.91 million female) only 74.59 million are milch animals. i.e. only 51% of female cattle are milch animals (39 % of total cattle). 125.75 million is the number of milch animals including cows and buffaloes



## Average Yield Rate for Milk \_ Annual report 22-23 DAHD

Exotic Cows (kg/day)	Crossbred Cows (kg/ day)	Indigenous Cows(kg/day)	Non- Descript Cows (kg/ day)	Indigenous Buffalo (kg/ day)	Goat (kg/ day) Non- Descript)	Buffalo (kg/ day)
11.36	8.32	4.07	2.83	6.62	4.81	0.47

which are either in milk or in dry period.

### Average milk yield per head

Considering the average milk production per animal exotic/cross bred animals yielding an average of 8.52 Kg per day and whereas the productivity of indigenous cattle is 3.36 L/day. Analyzing the trend of productivity of cattle and buffalo, it is sure that as stated in Annual report 2022, the trend shows an increasing rate during the past years. Cow head productivity is very low for India compared to other countries despite the fact that India remains number one in milk production for the past few decades with increasing trend in milk production. Developed countries are focusing on increasing their total production mainly by rising the productivity per cow and falling the total number of dairy cows.

“As per Integrated Sample Survey average annual productivity of cattle in India during 2019-20 is 1777 kg per animal per year as against

the world average of 2699 kg per animal per year during 2019 (as per FAO Statistics). Average productivity of cattle has increased by 27.95% between 2013-14 and 2019-20 which is highest increase in productivity in the World.” - Ministry of Fisheries, Animal Husbandry & Dairying.

Average milk yield per animal per day in India is markedly lower than those found in the United States (30 kg/day) and the United Kingdom (22 kg/day) -USDA Foreign Agricultural Service (FAS). North America has the highest average yields per cow among the major milk producing countries.

OECD-FAO AGRICULTURAL OUTLOOK 2021-2030 © OECD/FAO 2021

### Cow heads and greenhouse gas emission

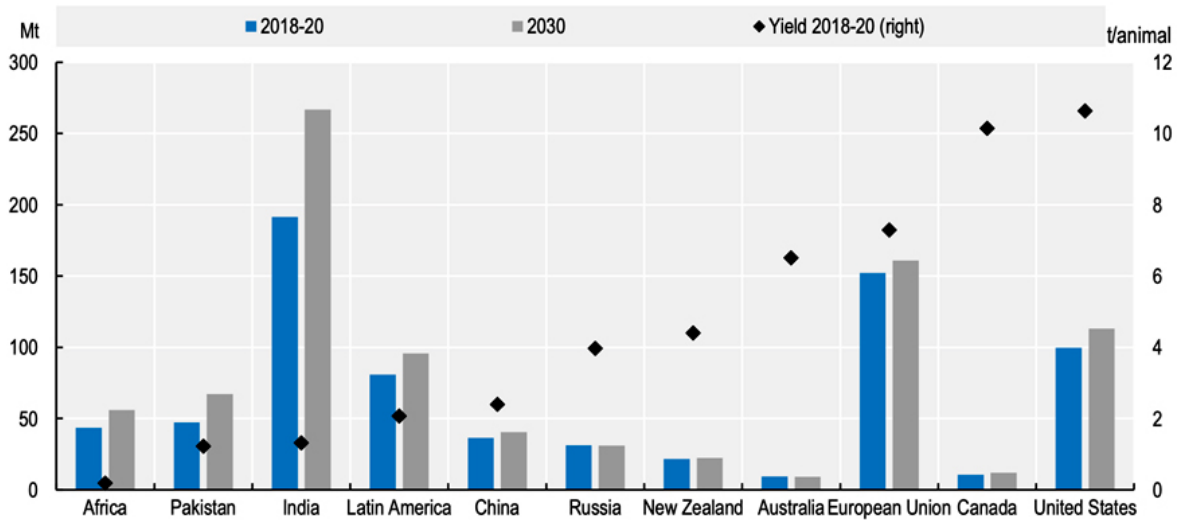
Climate changes and global warming affect the livestock production as it has direct and indirect impact on livestock and the resources on which they depend. On the other hand livestock production supply chain accelerates the greenhouse

gas effect contributing to climate change. Carbon di oxide, methane and nitrous oxide are the major emissions from livestock production systems which accelerate climate change. Direct emissions are from enteric fermentation and manure management. FAO estimates 10% of the sectors emission to be from manure management and 46% is attributed to livestock production, due to enteric fermentation from ruminants and on- farm fossil fuel use.

Greenhouse gas emissions are inversely related to productivity. At very low levels of milk production (200 kg per cow per year) emissions were found to be 12 kg CO<sub>2</sub> eq./kg Fat and Protein Corrected Milk (FPCM) compared to 1.1 kg CO<sub>2</sub> eq./kg of for high production levels (about 8000 kg of milk). This reflects the strong relationship between livestock intensification and greenhouse gas emissions across countries on a global scale (Gerber et al., 2011). A great control on emission from

## Cow heads and greenhouse gas emission

**Figure 7.4. Milk production and yield in selected countries and regions**



Note: The yield is calculated per milking animal (mainly cows but also buffaloes, camels, sheep and goats)

Source: OECD/FAO (2021), "OECD-FAO Agricultural Outlook OECD Agriculture statistics (database)", <http://dx.doi.org/10.1787/agr-outl-data-en>.

StatLink  <https://stat.link/7zem9c>

the sector can be achieved by reducing the number of heads of animal.

### Conclusion

India is the largest producer of milk, the largest consumer and having the world's largest dairy wealth. Per capita availability of milk in our nation exceeds that of world average. Milk production shows an increasing trend during the past years. Buffaloes play an important role in milk production - 45% of total milk production is from buffaloes and 52% from cows. Average milk yield rate of indigenous buffaloes is 6.6 kg per day while that of cross breed and indigenous cows are 8.32 kg and 4.07 kg per day

respectively. Annual average milk yield per animal is much lower compared to other leading milk producers in the world.

Milch cows play a major role in ensuring food security. With the growing population, demand for milk and milk products increases. We can't reduce total production and must aim at increasing the production to cope up with the growing demands. But increasing the number of heads of cows will worsen the greenhouse gas impact. So, when we aim at sustainable milk production, we must be cautious enough to reduce the carbon footprint from the sector. Along with adaptation strategies, mitigation practices

like selection of potentially good animals, culling the infertile and nonproductive animals and improving the yield of cows are very important in the current scenario where global warming and green house gas impact are threatening the life on the earth. The greenhouse gas emission per kg of milk (FPCM) produced can be reduced to a large extent if productivity of the animal can be increased. If the milk yield per cow can be improved, number of heads to be maintained can be limited so that the resource requirements will be reduced and carbon footprint by milk production will be controlled or decreased, without affecting food security concerns.

Millets are the super foods packed with incredible varieties of nutrients. These nutrient-dense grains are referred as 'Nutricereals' owing to the possession of high amounts of protein, vitamin, mineral, antioxidant, and flavones which can contribute towards food and nutritional security of the society.

Millets are small grained annual grasses adapted to marginal land over tropical and subtropical climates with low inputs.

The broader classification of millets includes major millets (Sorghum – *Sorghum bicolor*, Pearl millet – *Pennisetum glaucum* and Finger millet – *Eleusine coracana*) and minor millets (Foxtail millet – *Setaria italica*, Little millet – *Panicum miliare*, Kodo millet – *Paspalum*

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# Foxtail Millet

An  
underutilized  
Food cum  
Feed Nutri  
Cereal



*scrobiculatum*, Barnyard millet – *Echinochloa frumentaceae*, Proso millet – *Panicum miliaceum*, Brown top millet – *Brachiaria ramosa*). These millets are nutritionally superior to rice and wheat and the low glycemic index and gluten-free properties make it an absolute ingredient of diabetic and celiac disease patients diet.

Foxtail millet, a minor millet known for its early domestication among the millets, was first cultivated in China. Major areas of its cultivation in India include Andhra Pradesh, Karnataka, Telangana, Rajasthan, Maharashtra, Tamil Nadu, Madhya Pradesh, Uttar Pradesh, and to a small extent in the northeastern states. Contrary to its conventional use as bird and animal feed, foxtail millet shows phenomenal benefits as human food which remains unexploited. It is commonly known as Thina (Malayalam), Tenai (Tamil), Kangni (Hindi), Korralu (Telugu) and Navane (Kannada). The inflorescence is a long bristly panicle, mostly reddish or purplish which give the appearance of a fox's tail.

Foxtail millet is suitable for tropics as well as temperate regions and is a drought resistant crop. It is a short duration crop which can be grown even at higher altitudes (upto 2000 m). The crop grows lushly on well drained loamy soils and has low water requirement. The ideal time of cultivation is June to August as rain fed crop. For line sowing of foxtail millet, an average seed rate of





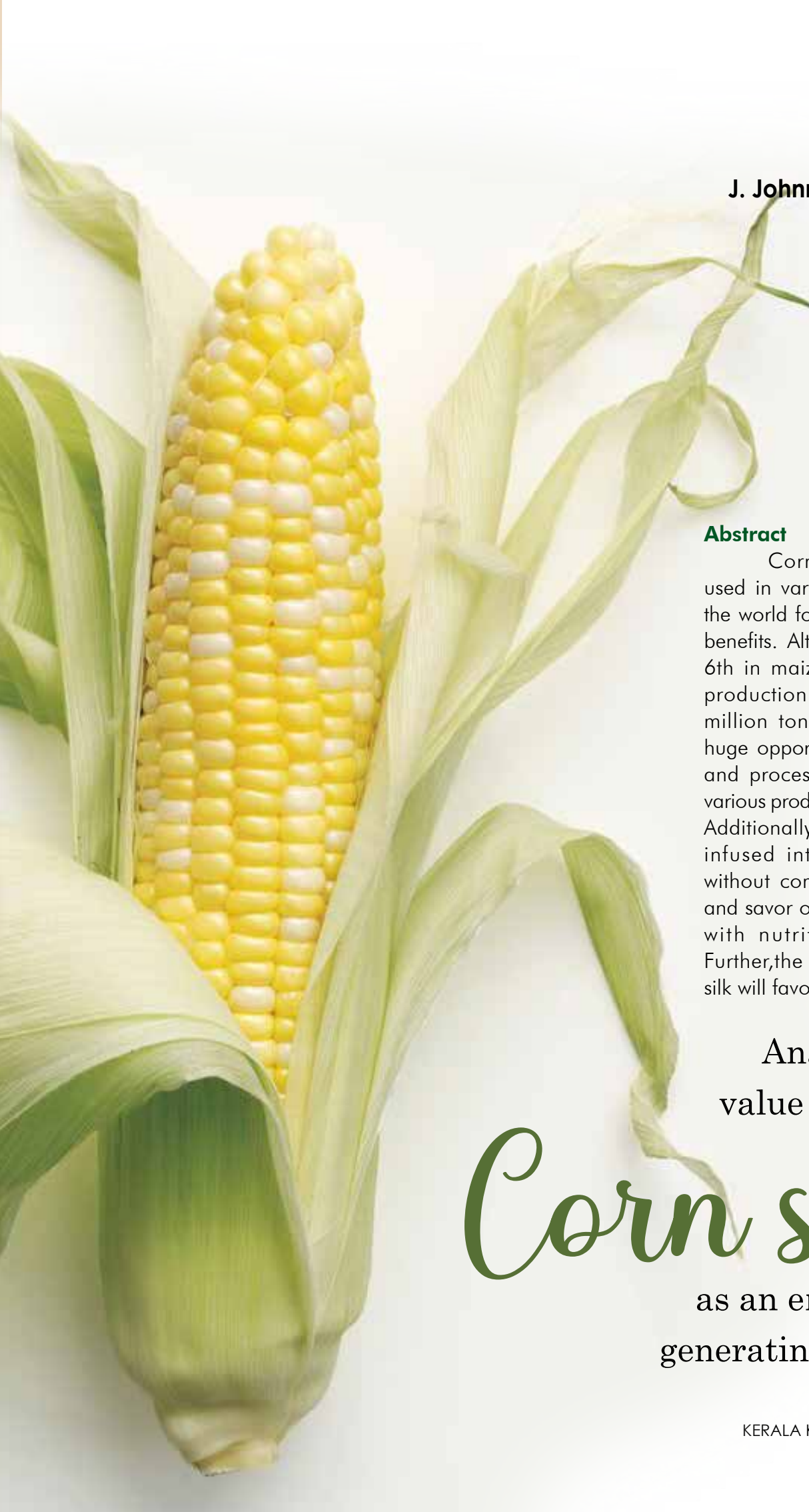
8 to 10 kg/ha is required, while for broadcasting, 15 kg/ha is needed. A spacing of 25 x 10 cm can be adopted for sowing and the seeds should be placed in a depth of 2-3 cm. Co-1, C-o2, Co-4, Co-5, CO (Te) 7, TNAU-43, Sreelaxmi and Suryanandi are some of the popular foxtail millet varieties. Apply farm yard manure @ 5 t/ha one month before sowing. Recommended fertilizer dose for foxtail millet is 40:20:20 kg N, P<sub>2</sub>O<sub>5</sub>, K<sub>2</sub>O per

hectare. Apply entire quantity of P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O and half the dose of N at the time of sowing and the remaining half of N at 30 days after sowing. Irrigation can be given on the day of sowing and after 3-4 days. If the rainfall is less, irrigate at fortnightly intervals. Weeding after 15 and 40 days of emergence of seedling is recommended. Foxtail millet can be harvested in 75-90 days when the earheads are dry by cutting the whole

plant or the ears separately. On average the crop yields 1-2 t/ha grains.

Foxtail millet is rich in nutrients, minerals and protein. 100 g of foxtail millet contains approximately 60.1 g carbohydrates, 12.3 g protein, 4.3 g fat, 331 Kcal energy, 31.0 mg Ca, 188 mg P, 81 mg Mg, 2.4 mg Zn, 2.8 mg Fe, 0.59 mg Thiamine, 0.11 mg Riboflavin, 3.2 mg Niacin and 15 µg Folic acid. The health benefits of foxtail millets include proper functioning of heart and nervous system, controlling weight and diabetes, maintaining health of bones and muscles and building strong immunity. These benefits are due to the presence of vitamins, protein, dietary fiber, low glycemic index, calcium, iron and other minerals. Foxtail millet can be used to make different types of dishes for breakfast, lunch and dinner including upma, dosa, appam, pulao, khichdi, biriyani and roti. It can be used as whole and can be grounded as flour.

As the United Nations General Assembly announced 2023 the International Year of Millets, various programmes and workshops are organized by different departments and institutions to spread awareness about the nutritional and health benefits of millets, cultivation aspects, processing and market opportunities to the producers and consumers. So in a health oriented community the consumption of foxtail millet should be encouraged and the production must be increased.



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### Abstract

Corn silk is has been used in various forms all over the world for its assured health benefits. Although, India ranks 6th in maize production with production of more than 30 million tonnes, the available huge opportunity for collecting and processing corn silk into various products is left unutilized. Additionally, corn silk can be infused into various snacks without compromising flavour and savor of the product along with nutrition enrichment. Further,the utilization of corn silk will favour employment

Analyzing the  
value addition of

# Corn silk

as an employment  
generating initiative



Beef Patty



cracker biscuit



Tea

generation by development of small scale cottage industries for processing corn silk into various products and also benefit maize farmers by providing a remuneration from corn silk. The processing and storing of corn silk doesn't need any high cost structures, it can be easily done by the farmer himself. This value added products prepared from corn silk will fetch a good price in the market and easily accepted by the peoples.

### **Keywords**

*corn silk, value addition, urinary health, employment generation*

### **Introduction**

Maize is one of the oldest cultivated crops in the world and has become a staple food like rice and wheat. As a C4 plant, it is grown mainly in tropics for its edible cobs and animal feed. Indeed, products like ethanol, oil, starch, flour, corn syrup are also derived from it. Although, corn is utilized to the maximum in India, consuming corn silk in the form a tea, laddoo, chappati and bread etc. is considered highly enigmatic. As a result of it, corn silk is considered as a waste and discarded. The health benefits underlying corn silk and the potential market behind it, needs to be realized for effective usage of this discarded part of maize cob among Indian population. Indeed, Corn silk tea, is not new to the world, but its origin is dating back towards Mayan & Aztec cultures, where it has been commonly used as a medicinal tonic. Besides that, corn silk is used to treat a variety

of ailments, including prostate problems, malaria, urinary tract infections (UTIs), and heart diseases in traditional Chinese and Native American medicine. Hence, we substantiate and narrate our views on the usage of corn silk in this article for the benefit of farming community, self-help groups, rural women and youths.

### **The need for value addition**

As per 2021 production statistics, India alone produced maize over an area of 9.89 million hectares with a production of 31.64 million tons. In this situation, a great opportunity of harvesting corn silk and processing it into a various commodities is being untapped for a long time. Besides it, a single dried cob can yield more than 1 gram of dried corn silk if properly collected. The rural women and farming community can easily process them by drying it in open sunlight and packaging them for sales. In addition, enrichment of dried corn silk with other potential ingredients is also possible and promote the health benefits and market value of this product. Additionally, this process also minimizes the farm waste generation during harvesting and processing of maize.

### **Medicinal benefits of corn silk**

Corn silk contains protein, vitamins, carbohydrates, Calcium, Potassium, Magnesium, sitosterol, stigmasterol, alkaloids, saponins, tannins, and flavonoids viz., maysin,



Chappathi



Parantha



sesame ladoo



Papaya Ladoo



Bread



Corn Raita

methoxymaysin, apimaysin, and luteolin derivatives. It is a naturally potent diuretic agent, removes excess water and waste from the body by increasing the urine flow. The increased urine flow significantly reduces the sediment formation in kidneys, which otherwise can lead to kidney stone formation. Indeed, nephrological ailments including painful urination, urinary tract infection, bladder infection, inflammation of the urinary system, kidney stones, etc can be effectively treated by this medicine. It is also reported that Corn silk tea improves bile secretion in liver and promote proper digestion. Corn silk is highly beneficial for diabetic people because of its enhanced pancreatic insulin generation properties. Compounds present in corn silk including stigmasterol and sitosterol are highly effective in preventing heart disease and high cholesterol. It is also registered that the consumption of corn silk tea makes the medicines to function better for patients who are affected by angina pectoris. Gout associated pains can be alleviated by intake of corn silk. It is also demonstrated that the corn silk has decreased the fat accumulation in the body and aiding weight loss.

### **Value added food products from corn silk**

Corn silk is considered to be a lesser known by-product from corn production with high nutritional value and antioxidant properties. Firstly the collected corn silk need to be washed

in 0.1% concentration of salt solution to remove foreign matter and dried to a moisture content of 7-10%. Then it was pulverized to use it effectively for preparation of value added food products. Bread and biscuit are the most common snacks eaten all over the world. Priyadharshini and Parameshwari, 2020 reported that the corn silk infused cracker biscuits has considerably reduced the formulation cost without affecting the flavour and savour of the product. Since yeast bread is always available, affordable, convenient and easy to consume, its value addition with corn silk powder makes it a better nourishment. The addition of corn silk powder (upto 10%) to prepare Laddoo of different blends like raw papaya, rice flour and sesame seeds is highly preferable. Dried corn silk and lemon fruit can be milled separately and mixed to produce corn silk lemon blended tea powder. Rosliet al., 2011 mentioned the nutritional enrichment values of beef patties with corn silk. Other products viz., parantha, Chapatti, raita and dal can be easily enriched with corn silk and used in daily life.

### Corn silk pills

As we mentioned earlier, the corn silk has scientifically proven weight decreasing properties and it has been utilized in the form of corn silk pills to control weight gain. The corn silk-based medications fetch a very high price and it is being commonly consumed as



Tablets

a dietary supplement for various health benefits viz., urinary health, optimal electrolyte balance, improving skin texture and weight loss. Primarily, corn silk is considered as a waste to be discarded, but if it is properly processed in the form of pills and tablets, its price must be around 15-20 rupees/pill.

### Easy preparation of corn silk tea

The tea can be prepared by simply boiling 2 cups of water and 2 table spoons of dried corn silk in a vessel and simmered in low heat for 10 minutes. Based on individual preferences, sweetener like sugar or honey can be added. The prepared tea can be consumed up to 3 cups a day. For children, the dose can

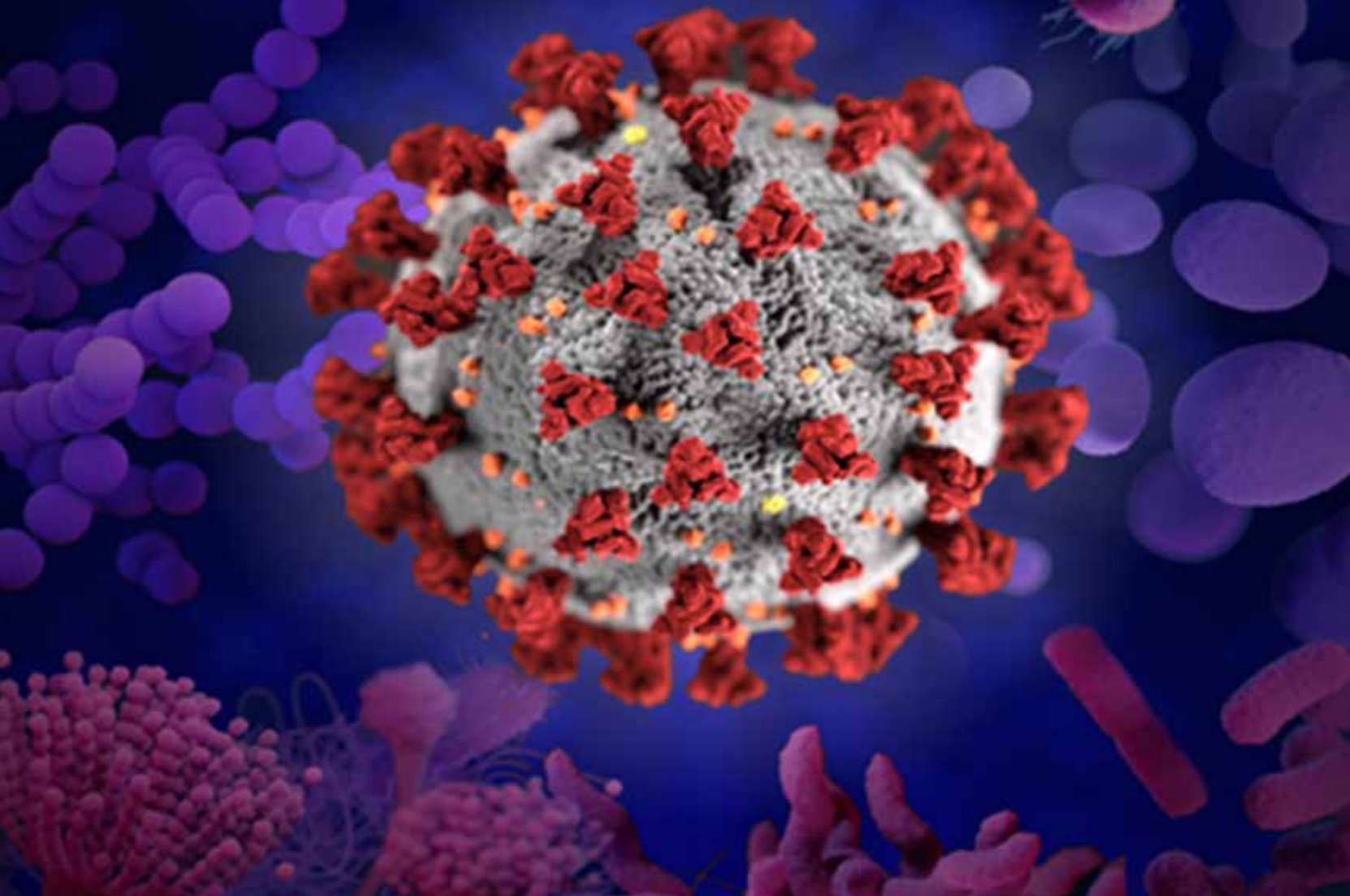
be reduced accordingly. The prepared tea is mildly earthy flavour to taste. Furthermore, the tea can be seasoned by mixing with other teas.

### Conclusion

The main aim for preparation of this manuscript is to create awareness among Indian farming community, self-help groups, rural women and youths about the usage of corn silk. Recently, The Centre for Monitoring Indian Economy (CMIE) reported that the rate of unemployment in the urban area was 10 per cent and the rural unemployment rate was 7.7 per cent in 2022. In this scenario, the collection and processing of corn silk into various products can be a considered as an employment generating initiative among the maize growing belts of India. As the people's mentality is shifting towards the alternatives for allopathy medications in this digital era, the products made from corn silk can be easily accepted by various groups of people.

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# ANTIMICROBIAL RESISTANCE

## SILENT PANDEMIC AFTER COVID 19

### Introduction

Antimicrobial Resistance (AMR) is one of the world's most serious public health threat adversely affecting the environmental sustainability of the planet. The threat of Covid-19 pandemic, zoonotic diseases and their environmental

dimensions has not taken seriously enough by the world. The Covid-19 pandemic is indeed a wake-up call to better understand and improve all areas of preparedness for and prevention of infectious diseases, including their environmental dimensions. The consequences

of the spread of AMR could be catastrophic and another pandemic hiding in plain sight.

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In 2019, antibiotic resistant infections were responsible for the deaths of 1.27 million people, with an overall 4.95 million deaths associated with complications from resistant bacterial infections. Immediate action is needed to tackle AMR or by 2050 it could cause up to 10 million deaths globally per year, on par with the 2020 death toll from cancer. By 2050 it is estimated that AMR could be responsible for a loss of 3.8% of the world's annual domestic product (GDP), by 2030 the GDP shortfall due to AMR could be US\$ 3.4 trillion per year, while 24 million more people could be

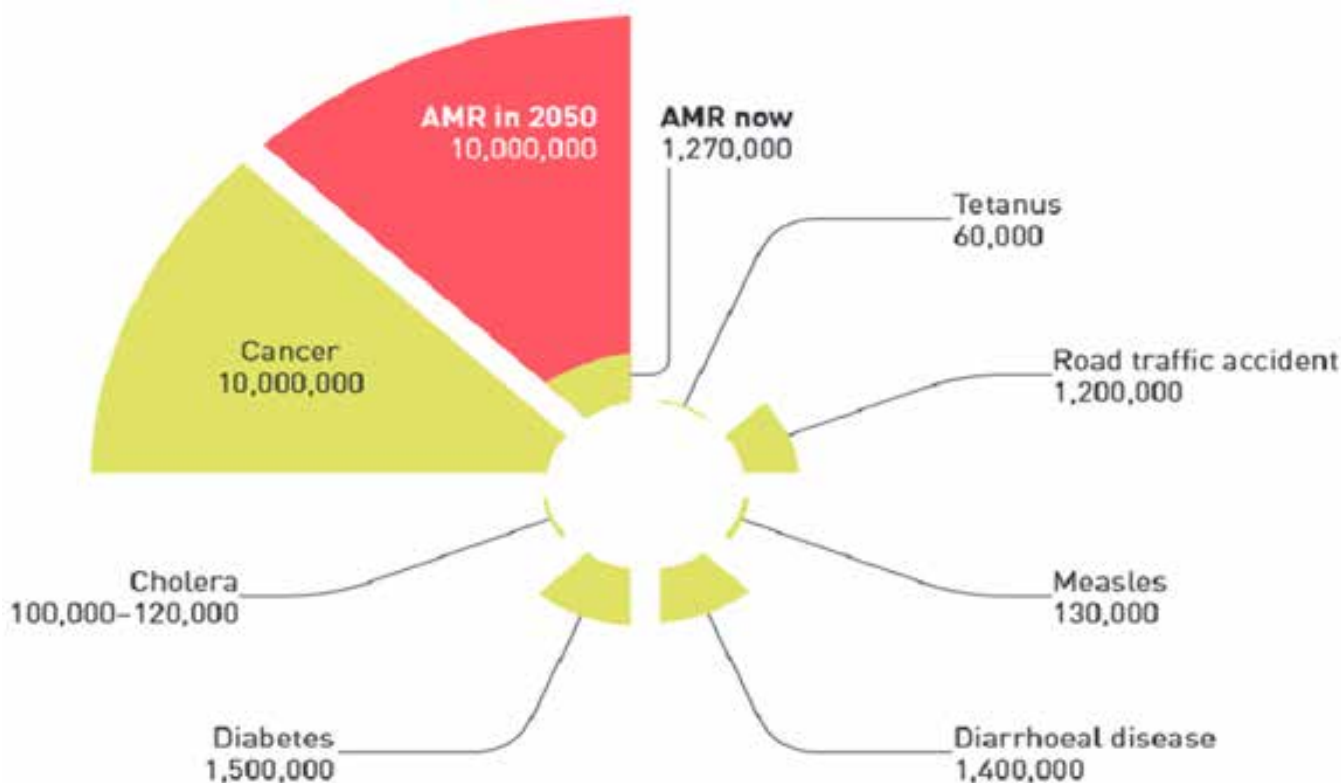
pushed into extreme poverty.

### Antimicrobial use in Humans, Animals and Plants

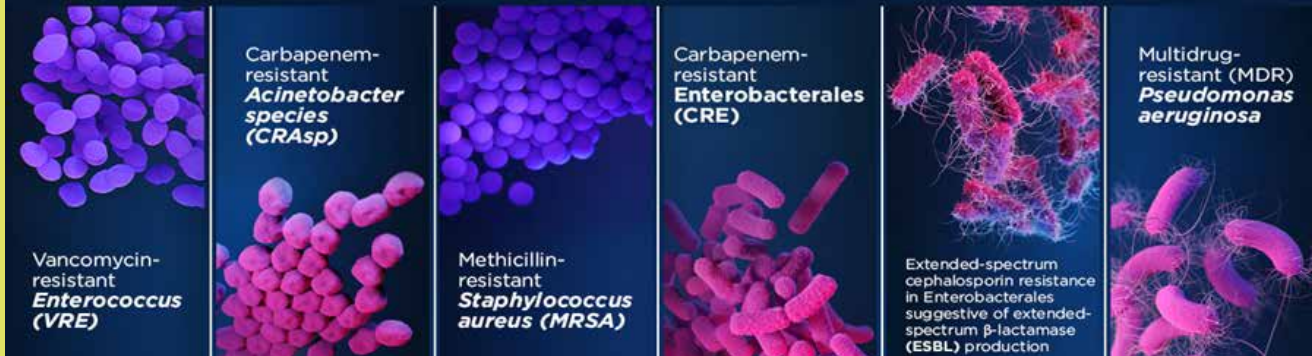
Antimicrobials have been widely used in animals, aquaculture systems, bees and plants. In animal production sector it has got various applications like prophylactic, therapeutic and growth promotion. But the quantum of antimicrobials used in animal sector are more comparable to humans. Most classes of antimicrobials such as broad-spectrum beta-lactams and quinolones are used in humans, veterinary and

aquaculture. Antimicrobials including tetracycline, triazoles and Streptomycin are used therapeutically in plants also.

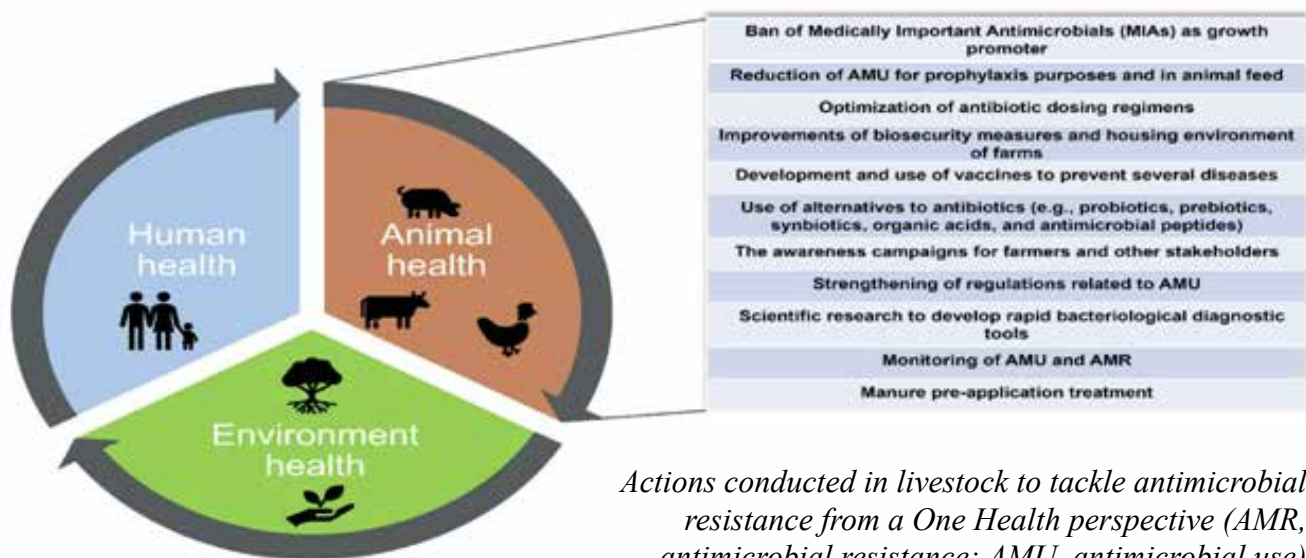
Antimicrobial resistance can be easily transferred between and within different ecosystems and populations; resistant zoonotic bacteria can be found in the soil, and from there they can infect plants, vegetables and fruits. Classes of antimicrobials such as carbapenems are intended for human use, whereas the flavophospholipol and ionophores are common drugs in veterinary practise. Antimicrobials such as tetracycline and streptomycin,



**6 of the 18 most alarming antibiotic resistance threats cost the U.S. more than \$4.6 billion annually**



*Six out of the 18 most alarming antibiotic resistance threats, (vancomycin-resistant Enterococcus, carbapenem-resistant Acinetobacter species, methicillin-resistant Staphylococcus aureus, carbapenem-resistant Enterobacterales, extended-spectrum cephalosporin resistance in Enterobacterales, and multidrug-resistant Pseudomonas aeruginosa), costs around more than 4.6 billion U.S. dollars.*



*Actions conducted in livestock to tackle antimicrobial resistance from a One Health perspective (AMR, antimicrobial resistance; AMU, antimicrobial use)*

are used for prophylaxis and treatment against bacteria that cause fruit infection. Residues of antimicrobials used in aquaculture may remain in fish products and aquatic environments for a long time, exerting selection pressure on

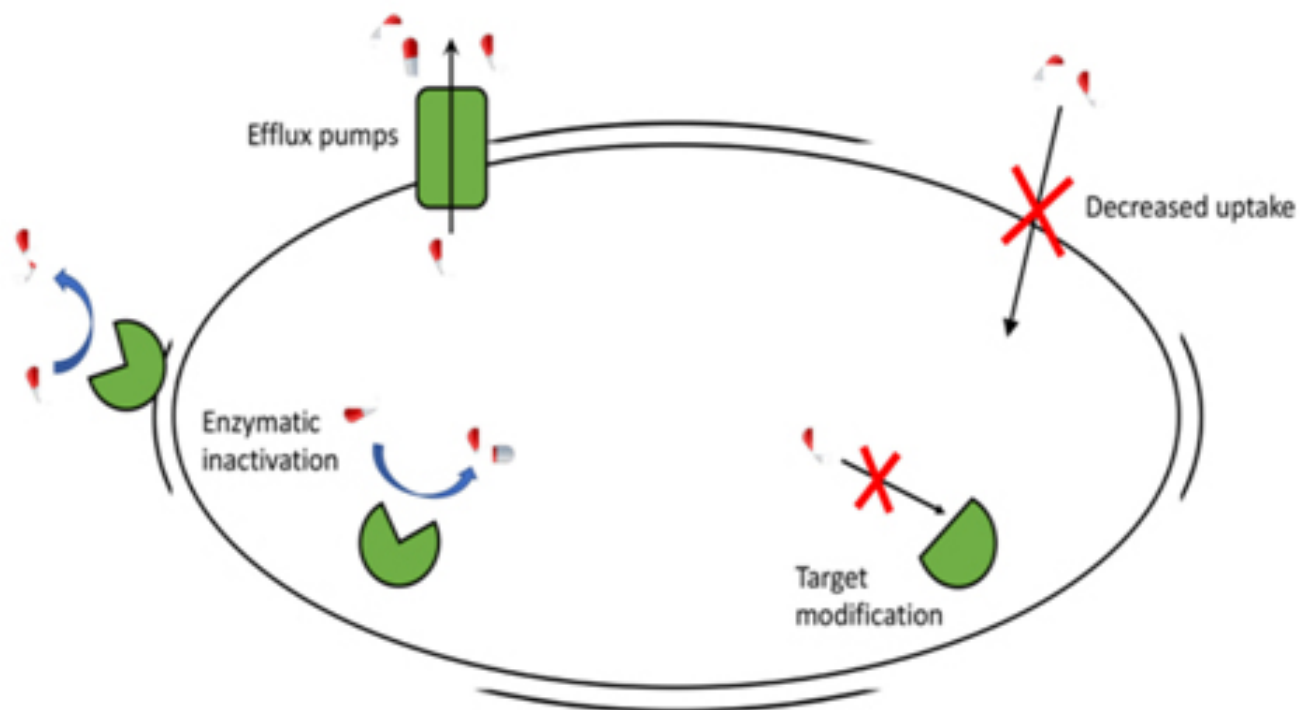
microbes for the development of AMR. Therefore, a 'One Health' approach unifying and integrating the health of people, animals, and ecosystems is the need of the hour.

Actions conducted in livestock to tackle antimicrobial

resistance from a One Health perspective (AMR, antimicrobial resistance; AMU, antimicrobial use)

**Antimicrobial resistance and its development**

Microbes such as bacteria, viruses, parasites and



fungi are said to be antimicrobial resistant, when they were longer responding to the drugs, leading to long hospital stays and failure of therapy. Development of superbug like New Delhi metallo  $\beta$ -lactamase 1 (NDM-1) positive Enterobacteriaceae have further complicated the management of infections. There are four mechanisms through which bacteria become resistant to antibiotics. It includes enzymatic inactivation, drug extrusion by efflux pumps, decreased uptake by changes in the outer membrane permeability or by pressure of porins and modifications of the drug target. Antimicrobial resistance can be intrinsic or acquired, the latter

can occur through mutations, the acquisition of DNA from different microbes, or in the case of bacteria horizontal gene transfer (HGT) of mobile genetic elements. Through the complex interactions across nature, the resistant microbes could be transmitted to humans, food animals, plants and wildlife. They also pose a significant threat to human, animal and plant health and food security. Mechanisms through which bacteria become resistant to antibiotics (Antibiotics as red and white pills, target proteins in green)

### Strategies to Combat antimicrobial resistance

The effective control

strategies to combat AMR have been complicated by the development of superbugs and the global spread of antibiotic resistance. So, the prevention and control of AMR should be implemented at the international, national and state level. Some of the recommendations are improving personal and hand hygiene, rational use of antimicrobials and regulation on over-the counter availability of antibiotics.

### (a) AMR Global Action Plan

Antimicrobial resistance global action plan (GAP) was adopted at the WHO world health assembly in 2015. One of the objectives of this action plan was to raise awareness of

AMR worldwide, by launching the “Global antimicrobial awareness week”. From 2020, it is called “world antimicrobial awareness week”, referring to all antimicrobials: antibiotics, antifungals, antiparasitic and antivirals.

**(b) National Antimicrobial Resistance Policy - India**

To rationalise the use of antimicrobials and to encourage the development of new antimicrobials, a national antimicrobial resistance policy for containment of AMR was introduced in 2011. Establishing AMR surveillance system, strengthening infection prevention and control measures and educate, train and motivate all stakeholders in rational use of

antimicrobials are some major action points in the national policy.

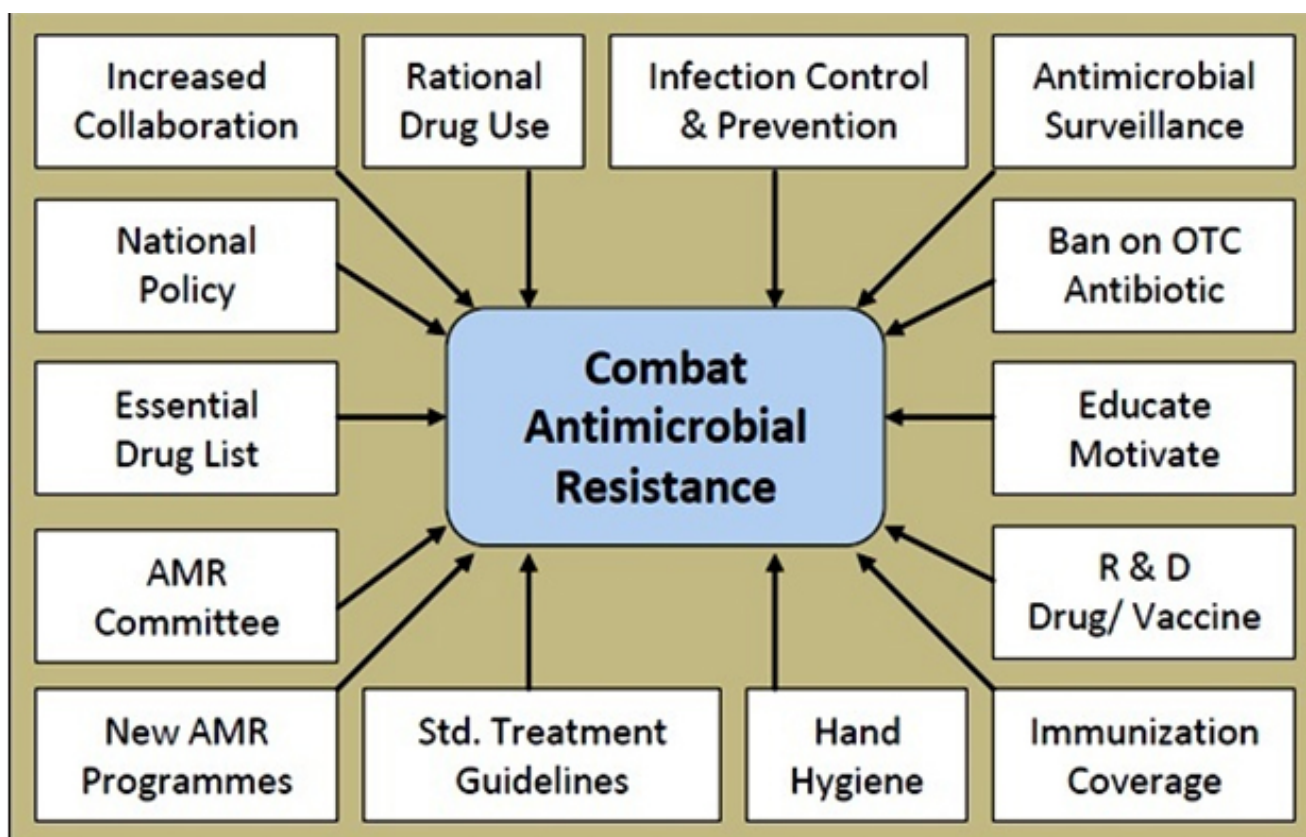
**(C) KARSAP: Kerala Antimicrobial Resistance strategic Action Plan**

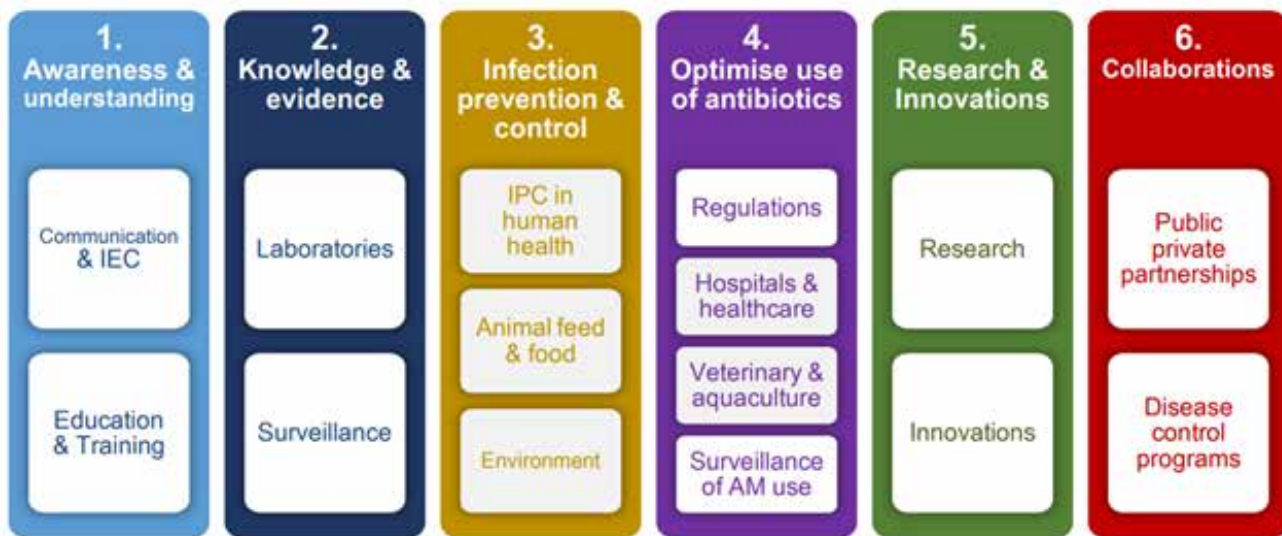
The Government of Kerala had developed and implemented the state action plan on AMR, in alignment with the National action plan on AMR (NAP-AMR) and the global action plan on AMR (GAP-AMR), by involving all stakeholders of the state agriculture, medical and animal husbandry departments. The Kerala antimicrobial resistance strategic action plan (KARSAP) has 6 strategic priorities. It includes, awareness and understanding, knowledge and

evidence, infection prevention and control, optimising use of antibiotics, research and innovations, and collaborations. Inter-sectoral collaboration and a one health approach are the main pillar stones of KARSAP.

**Novel strategies to combat antimicrobial resistance**

Bacteriophage therapy, combination drug therapy, faecal microbiota transplantation, antimicrobial peptides and adjuvants are some of the novel strategies to combat AMR. Resistance to single antimicrobial became prominent in organisms that encountered the first commercially practiced antibiotics. The novel approach of ‘combination drug therapy’ will be helpful in treating the infections





with set of drugs rather than individual monotherapy. Faecal microbiota transplantation / stool transplantation involves the transplantation of faeces from a healthy donor to a recipient and it aims at the total restoration of the gut commensals. Bacteriophage therapy/viral phage therapy is a magical cure for many antimicrobial resistant infections. Small doses of bacteriophages are required to treat bacterial infections as they self-replicate in vivo and are less immunogenic.

### Conclusion

Antimicrobial resistance is one of the rising global burdens associated with increased morbidity and mortality in clinical and community setting. A 'one health' approach collaborating all stakeholders dealing with human, animal and plant health are inevitable to combat AMR. The South Indian state - Kerala, was one of the first in India to implement the Kerala antimicrobial resistance

strategic action plan (KARSAP) for combating AMR in 2018, incorporating one health. Modalities like combination therapy, bacteriophage therapy, faecal microbiota transplantation, antibiotic adjuvants and antimicrobial peptides form the hope for the future to curb the development of antimicrobial resistance.

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# “FUNCTIONAL FOODS

## Enhancing Health Through Everyday Nutrition”

**H**ave you ever wondered if there’s a way to turn your everyday meals into extraordinary sources of vitality and well-being? Today, more and more people are mindful of their health, paying close attention to food labels to ensure they choose wisely. With their special blend of nutrients, compounds, and proven advantages, functional foods have the power to transform your diet into a source of vitality and wellness. Adding these amazing foods to your meals can enhance your overall health and enjoy the positive benefits they bring. These incredible foods offer a unique blend of nutrients, compounds, and proven benefits that can turn your diet into a source of well-being and vitality.

### **What Are Functional Foods?**

Functional foods are a category of foods that, when incorporated into our regular diet, offer more than just essential nutrients. These foods contain specific bioactive compounds that



go beyond basic nutrition, providing additional health benefits alongside traditional nutritional value. They have gained immense popularity worldwide due to their ability to promote good health and reduce the risk of diseases. The concept of functional foods was initially introduced and regulated by the Ministry of Health and Welfare in Japan during the 1980s. The Ministry established criteria for functional foods to bear a special seal and be recognized as Foods for Specified Health Use (FOSHU). Drawing from its own cultural heritage and traditional practices, India is actively exploring the benefits of functional foods. By conducting research, clinical trials, and establishing guidelines, India aims to harness the power of functional foods and offer its population safe and effective options for improving their well-being, just like Japan's FOSHU system has done for its citizens.

### **Types of functional foods**

#### **1. Altered foods**

A food from which a harmful component that is known to cause negative effects when consumed, is removed or replaced. For instance, Gluten (allergen) free products, are food products with artificial sweeteners in which sugar is replaced by artificial sweeteners.

#### **2. Fortified foods**

Foods with added additional nutrients that were not originally present or were present in insignificant amounts. For example, milk fortified with Vitamin D and orange juice fortified with Calcium.

#### **3. Enriched food**

Enriched foods are products that have had certain nutrients restored to their original levels or added back after they were lost during processing. For instance, wheat flour enriched with B vitamins and Iron which may be lost during processing

#### **4. Enhanced Foods**

Foods in which a specific component is enhanced naturally by maintaining specific conditions such as altering feed, and genetic manipulations for its special growth. For example, eggs with increased omega-3 fatty acids can be achieved by adjusting the feed given to chickens, resulting in naturally enriched eggs.

A collage of fresh vegetables including lemons, asparagus, green beans, and avocados. The background is a light, textured surface. On the left, there's a wire basket with lemons and a lime. Below it are green beans, asparagus, and a small jar of dressing. On the right, there's a wooden cutting board with sliced green beans, a bunch of green onions, and a knife. At the bottom right, there are two halves of an avocado and a lime slice.

## 5. Non-Altered Food

Foods that naturally have an increased content of nutrients. Fruits and vegetables with phytochemicals are examples.

### Health Benefits of Functional Foods

Functional foods possess a wide range of health benefits and can aid in the prevention and treatment of various diseases, such as cancer, cardiovascular disease, and diabetes. These foods contain bioactive components that contribute to their health-promoting effects. By incorporating functional foods into a balanced diet and adopting a healthy lifestyle, one can harness their potential to enhance overall well-being and reduce the risk of certain illnesses.

#### *Incorporating Functional Foods into Your Diet*

*Here are some practical tips for incorporating functional foods into everyday meals and snacks*

**Reading labels:** Understand product labels to identify functional foods and their specific health claims.

**Identifying key ingredients:** Look for specific functional components, such as probiotics, antioxidants, or omega-3 fatty acids.

**Breakfast boost:** Add berries or flaxseeds to your morning cereal or yogurt for an antioxidant and fiber boost.

**Power-packed lunches:** Include a variety of vegetables, leafy greens, and lean proteins in your side dishes or salads.

**Wholesome dinners:** Experiment with whole grains, legumes, and a range of colorful vegetables for a nutrient-rich plate.

**Snack smart:** Opt for natural yogurts, mixed nuts, or fresh fruit as healthier alternatives to processed snacks.

Remember, incorporating functional foods into your diet is about making gradual and sustainable changes. Start by selecting a few functional foods that align with your preferences and gradually expand your choices over time. Enjoy the process of discovering new flavors and the positive impact functional foods can have on your overall well-being.



Food	Bioactive Food Component/Class	Potential Health Effects
Fruits	Beta-carotene, Anthocyanidins and flavones	Antioxidants, reduce risk of cancer
Fermented milk/dairy	Bioactive peptides, probiotics, calcium, and protein, conjugated linoleic acid	Supports gut, immune, cardiovascular and metabolic
Oats, Barley	Beta-glucan, phytochemicals	Dietary fibre act as prebiotics, help reduce cholesterol and blood pressure
Soyfoods	Isoflavones	Reduces LDL cholesterols
Cruciferous vegetables	Glucosinolates, vitamins C and K, manganese, folate, potassium, Dietary fiber	May reduce the risk of certain cancers such as colorectal, mouth, pharynx, larynx, and lung cancer
Fatty fish	Omega-3 fatty acids	Lowers cholesterol, and triglycerides, improves cardiovascular health
Whole grains	Flavonoids, saponins, lignans, resistant starch, B-vitamins, vitamin E, selenium, manganese, dietary fiber, and protein	Improves gut and cardiovascular health, and may reduce the risk of colorectal cancer

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## Introduction

Indian population is expected to be about 1.66 billion in 2050 and it is a big challenge for India to provide food for our enormous population. Kerala is having a predominantly agrarian economy and rice is the staple food of the people. Nevertheless, the rice lands have a prominent role in the ecology of this beautiful small state known as 'Gods' own country'. Rice cultivation is the most essential and important food

production activity in Kerala. The highly labour intensive rice cultivation practices were not economically sustainable in Kerala, where high wage were rampant. Due to this the area under rice has seen a rapid decline during the last four decades. We owe much to agricultural machines in raising the productivity on the limited land because timely and precise farming operations are essential to increase productivity. Even though there was a controversy

on the desirability of rice mechanisation in Kerala during the sixties and seventies, the role of mechanization is regarded as the most important component for sustaining rice production in the current situation.

Palakkad district alone accounts for more than 40% of the total two lakh ha of rice area in Kerala. Krishi Vigyan Kendra – Palakkad had taken up mechanisation of rice cultivation as its flagship programme during the seven years from 2007 to

# Sustaining Rice Cultivation through Mechanisation

## Experiences from Palakkad, Kerala

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*Fig.1. Rotavator*





**Fig. 2 KAU Helical blade puddler**

2014 and has implemented widespread activities for evolution as well as popularisation of mechanisation technology viz. on-farm testing programmes, front line demonstrations, awareness classes for farmers and training programmes for rural youth and agricultural labourers. Along with other promotional policies of the State Government, these efforts could help in sustaining rice cultivation in the district. New programmes like SMAM (Sub Mission on Agricultural Mechanisation)

### **Back ground of rice machinery use in Kerala**

The small size of holdings in Kerala which are mostly less than one ha and the high cost

of machines posed a prominent bottleneck in the adoption of machines in rice cultivation. The policy makers also had apprehensions on labour displacement consequent to rice farm mechanisation (James, 1989). But there were also reports (James et al., 1995) that the fear of labour displacement due to agricultural mechanization was baseless and rice farm mechanization can actually offer employment opportunities in the operation, service, manufacture and marketing of machines, which the educated youth of this highly literate state will find more attractive. In many instances, it was observed that demand for labour in agriculture increased

due to mechanization consequent to increased cropping intensity. It was also suggested that the cost of cultivation of rice in Kerala can tremendously be reduced by selective mechanisation, as the wage rates in Kerala were the highest in India (James et al. 1996). Mechanization of highly labour-intensive operations like transplanting and harvesting was likely to offer a helping hand to the farmer and a group mechanisation strategy was recommended for adoption of rice machinery (James and Pillay, 1998).

### **Evolution of a Package of Rice Machinery**

Even though rice is cultivated in diverse situations,



**Fig. 3** Mat nursery for rice transplanter

there are three major systems in Palakkad district. In dry seeded system, the sowing is done before the onset of monsoon,utilizing the moisture from pre-monsoon showers for land preparation. Wet seeding is done with sprouted seeds in ‘puddled’fields where the geo-physical condition is congenial for draining water after ‘puddling’ (practice of churning soil in presence of standing water in the field so as to prepare a least pervious soil layer and make the soil soft).

In transplanted system, a nursery is raised and the 12-30 days old seedlings (age depending on methods) are transplanted to the main field, usually after the onset of monsoon. The implements and machinery differ only for pre-harvest operations (till the crop ripens).Consequent to a series of on–farm testing programmes, a set of machinery for rice cultivation in Kerala was

proposed by James (2008) for the predominant cultivation systems viz. dry seeded, wet seeded and transplanted systems. On-farm testing programmes were organised in farmers’ fields to assess the suitability of different implements and machines for each system. Recommendations were made based on the results of these studies and were demonstrated in farmers’ fields. These recommendations were

thereafter included in the Package of Practices Recommendations of Kerala Agricultural University (KAU, 2016).

### **Pre- harvest operations in Dry Seeded System**

**Land preparation:** Primary tillage operations are generally undertaken using tractor operated cultivators. Mould board ploughs, disc ploughs or disc harrows were seldom used and they did not seem to be essential to satisfy the agronomic requirements. Rotary tillage implements like power tiller (rotary tiller) or tractor operated rotavator could ensure better pulverisation and fine tilth required for dry seeding. Tractor operated rotovators were recommended as they were suitable for speedy operation with less energy expenditure.

**Seeding:** Seeder attachment to cultivator, with cup feed type of seed metering mechanism,was recommended for dry seeding in rows. Line sowing in rows separated by 200 mm

**Fig. 4** Yanji-Sakthi rice



could enable optimum plant population and facilitate the use of mechanical weeders. But the implement could not get much acceptability in the state due to clogging in the seed tube, difficulty for use in small fields, inability to vary seed rate and its high cost. It was not easy for the farmers to attach and detach the seeder to the tractor drawn cultivator, contrary to the expectation. Hence it was decided to suggest modifications and refine the seeder through On Farm Testing programme of KVK Palakkad.

### Pre harvest operations in Wet Seeded System

Land preparation for wet land paddy cultivation is done by churning soil in standing water, called 'puddling'. Puddling is done with tractors and power tillers attached with special steel wheels called 'cage wheels'. Even though cage wheels are intended to provide sufficient traction for tractors in wet lands, they are commonly used as an implement for manipulating soil by churning. Generally, 7 to 10 hours of cage wheel puddling with tractor is required per ha of paddy field, whereas 'KAU helical blade (rotary) puddler' is an additional attachment to tractor. Compared to cage wheel puddling, about 40-45 % reduction in operation time resulting in 35-40% reduction in fuel consumption (per ha) can be achieved by the use of this improved puddler. Smooth operation and less clogging



*Fig. 5 Four-wheel riding type rice*

with aquatic weeds are other advantages. Rotovator attached to tractor can also be used for puddling depending on the soil condition, but when the bunds are high it is difficult to move from one field to other with a heavy implement like rotovator. Hence the technology of KAU Helical blade puddler, developed at Regional Agricultural Research Station by the author was transferred to Metal Industries Ltd., Shoranur, a Kerala Government undertaking.

**Seeding:** Pre-germinated paddy seeder (modified IRRI model drum seeder) manufactured and distributed by Regional Agro-Industrial Cooperative Ltd. could be used for line sowing of sprouted seeds in rows. The implement can be pulled by a single man and has four plastic drums which provide a row spacing of 200 mm. Instead of a single lugged wheel in the IRRI design, this modified drum



*Fig. 6 Power operated paddy*

seeder has two wheels on either side.

### **Pre harvest operations in Transplanted system**

Equipment for puddling is same as those recommended for wet seeded system. It is better to avoid over puddling (use of rotovators in certain soil condition) for use of transplanting machines. Proper settling time for puddled soil shall be given, depending on the soil condition.

### **Mat nursery preparation**

In the early days of mechanised transplanting, farmers regarded preparation of mat nursery as a difficult process. In the course of transplanter use, mat nursery preparation techniques have been locally adapted. Presently, mat type nursery is prepared by carefully sowing sprouted seeds on seed beds of about 100 mm width made by spreading about

12 mm thick soil layer on a polythene sheet of appropriate length. Mat nursery may be prepared as dry nursery as well as wet. Dry nursery can be prepared on rigid flat surfaces also without using polyethylene sheets.

### **Transplanting machines**

The efforts to popularise the 6 row IRRI model manual transplanter during the second half of eighties could not succeed as it could not catch up with the farmers' aspirations in Kerala. Chinese 8 row riding type rice transplanter (Yanji) with a row to row spacing of 238 mm was the popular self propelled transplanter introduced first in Kerala. The machine became popular consequent to the scientific evaluation of the machine done by the Agricultural Engineering division of the Regional Agricultural Research

Station, Pattambi, Kerala (Anonymous, 1997). In the field studies it was established that there was no significant difference in yield compared to manual transplanting. Field capacities of the popular machines were in the range 0.2-0.25 ha/h depending on field condition.

But, limitations have been observed in the sliding platform type transplanters in adverse geophysical conditions. The inherent difficulty in bund crossing, the inability of the single front wheel in propelling the machine in slushy soil condition and the requirement to fully drain the field are the major draw backs observed in field trials. Hence, the four row walk behind type rice transplanters with 300 mm row spacing and variable hill to hill spacing has also been popularised by KVK Palakkad during 2008-2010. The field

**Fig. 7 Kamco reaper KR 120**



capacities of these transplanters were in the range 0.15-0.18 ha/h.

Apart from the above small machines, four-wheel riding type (6 and 8 rows) transplanters were also found suitable with the added advantage of better and speedy operation even in adverse geophysical conditions. KVK had conducted extensive demonstrations with an imported Japanese (Kubota) machine. These machines generally have field capacities in the range of 0.35 to 0.45 ha/h. The high cost of imported machines (Rs.1-1.2 million) is the major constraint in their use. Most suppliers fail to provide timely service and supply of spare parts, which is another hurdle in the spread of transplanters.

### **Weeding implements**

Double rotor cono weeder (IRRI model) and single rotor finger type weeder are useful for wet land weeding, even though they are not very popular owing to the drudgery in manual operation. Single rotor weeders were found more suitable in heavy soils where cono weeders are difficult to be pushed. Of late, power operated 3 row weeders (Japanese design) introduced by Krishi Vigyan Kendra is getting popular.

### **Machinery for reaping, threshing and harvesting**

The selection of machinery for harvesting is dependent on the geo-physical



**Fig. 8 Track type combine harvester**

conditions as well as economics. A reaper-thresher combination can be useful in small holder agriculture. But, if a group management of larger areas is possible, combine harvesters are obviously advantageous.

### **Reaping machine**

KAMCO reaper (IRRI model vertical conveyor reaper) produced by Kerala Agro Machinery Corporation is suitable for operation if the fields are fairly dry during harvest season. The machine is powered by a 3.5 hp engine. The cutting width is 120 cm and is capable of reaping and windrowing about 0.2-0.25 ha/h depending on field condition.

### **Threshing machines**

Hold-on type simple threshers with wire loop threshing drum powered with a 1.125 kW electric motor and capable of threshing @ 50-100 kg threshed grain per hour is suitable for small scale farmers. This is a

power operated version of the old pedal operated Japanese hold-on type thresher. The crop bundles are manually held against the rotating drums. Tractor PTO operated axial flow threshers can thresh the crop from one ha in about 4 hours. Many farmers in the district prefer the use of these machines as straw is not damaged and hence fetch a better price. In 'flow through type rasp bar threshers' the crop fed to the thresher pass between the concave and rasp bar threshing drum in a radial direction (cross flow), as against the axial flow threshers. They are powered by either a diesel engine or electric motor (power range: 3.75-5.625 kW) and can thresh about 400-500 kg of grain per hour. The latter two threshers can be towed to the field as they are fitted with pneumatic wheels. They also have inbuilt cleaning mechanisms comprising of a series of oscillating sieves and a

blower.

### Rice Combine Harvesters

James et al (2006) have made an economic evaluation of rice combines. The three different combine types suitable in Kerala were large track type combines with flow through thresher, small track type combines with ear head threshers and pneumatic wheel combines. High capacity track type rice combines (European design, Claas) with flow-through threshing mechanism are conveniently used for slushy field conditions. The machines are powered with diesel engines of 40-45 kW with a cutting width of 2.4 m and a field capacity of about 0.4 ha per hour. The cut crop is fully conveyed into the

threshing unit and the cleaned grain is temporarily stored in the grain tank of about 1 metric tonne capacity. The bruised straw is discharged to the field and difficult to be collected and bundled.

Small track type combines (Japanese and Korean makes) with ear head threshers have better manoeuvrability in small fields but the major constraint in their use is timely in-situ service facility and difficulties in getting spares. These machines have become obsolete, consequent to the popularisation of straw bailers.

### Wheel type combines

Many wheel type combines manufactured in India are

suitable for harvesting paddy when the field is dry enough for their operation. The field capacity is comparable to other high-capacity track type combines and their initial costs as well as maintenance costs are comparatively low. Most machines are manufactured indigenously and have better service facilities compared to imported machines.

### Straw balers

Tractor pto operated straw balers are ideal for recovering straw from combine harvested fields. Both round and cube straw balers are now available. Round balers which are attached behind the tractors are more suitable in small plots, whereas offset mounted cube balers are better suited in large plots. Both machines are getting popular as rice straw is in good demand due to its wide use as cattle feed and as a packing material.

### Awareness and Training programmes

Confidence of farmers on the profitability of rice cultivation through mechanisation could be built through a series of awareness programmes throughout the district from 2007 onwards. The vocational training in rice machinery operation were also started simultaneously. The first group included unemployed rural youth and middle-aged small-scale farmers from Vilayur grama panchayat. Subsequent to the training from KVK, the Vilayur grama panchayat as well as the Department of

*Fig. 9 Straw baler*





agriculture provided machines to this group. They started their venture with a sliding platform-riding type transplanting machine. Encouraged from their success story, the Pattambi Block panchayat also formulated a labour support group which was trained by KVK. They were also provided transplanters and other machinery by the block panchayat and district panchayat. Later, KVK started extensive trainings for the labour-support groups formed in several grama panchayats. KVK has trained all the 9 labour support groups under Alathur block panchayat and they were provided with machines including power weeders on the recommendation of KVK. The achievements of 'Haritha Thozhilsena', a women group in Kizhakkencherry grama panchayat were noteworthy. The group comprised of twenty ordinary women labourers. They were trained by KVK during 2010-11 and they started their work by leasing fallow lands as well as offering transplanting service with hired machines. The Palakkad district panchayat supported many such groups by providing machines to them. The Agricultural Engineering wing of the Department of Agriculture in Palakkad District also supported these groups by offering them machines on hire basis. The synergy of all these agencies with KVK has helped the spread of mechanisation in the District in a big way. Four of the KVK trained groups were presented

with modern four wheel type six row transplanting machines by the Palakkad district panchayat. The KVK trained labour support groups have been brought together as 'Paddy Protection Task Force' and a directory was also published.

### **Demonstration of machinery packages through group mechanisation**

The advantages of mechanisation can be fully realised only if small farmers in an entire 'padasekharam' (agglomerated paddy fields with similar geo-physical characteristics) join together and adopt mechanisation as a group. The cost of transportation and other overheads for costly hired equipment can be minimised in group mechanisation. Another major activity of KVK to promote mechanisation of small holder rice cultivation was the implementation of group mechanisation as a Front-line Demonstration programme. During the five years from 2010, the package of rice machinery for transplanted system was demonstrated on a 'padasekharam' basis in several grama panchayats like Pattithara, Kodumbu, Kizhakkencherry, Vadakkencherry etc. Learning from the success of these padasekharams, farmers of nearby padasekharams came forward to implement group mechanisation with the assistance of the KVK trained labour support groups.

### **Concluding remarks**

Palakkad district continues to be the rice bowl of Kerala and the KVK Palakkad could build up a confidence among farmers to adopt mechanisation of rice cultivation. A rice machinery package has been evolved by KVK by organising on-farm trials in farmers' fields. The spread of mechanisation in rice cultivation was instrumental in arresting the fast rate of depletion of paddy lands. This has been achieved through concentrated efforts for almost seven years during 2007 to 2014 by organising awareness programmes, demonstrations, trainings and farmers field schools. The synergy of KVK with department of agriculture, local self-government bodies, and various stake holders like 'padasekhara samithis' have been the major factor in the spread of mechanisation technology in the district. In appreciation of these activities KVK Palakkad was awarded the 'Best KVK award' of the Indian Council of Agricultural Research in the year 2014.

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