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Artificial Intelligence and Second Green Revolution

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Artificial Intelligence and Second Green Revolution

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ABSTRACT

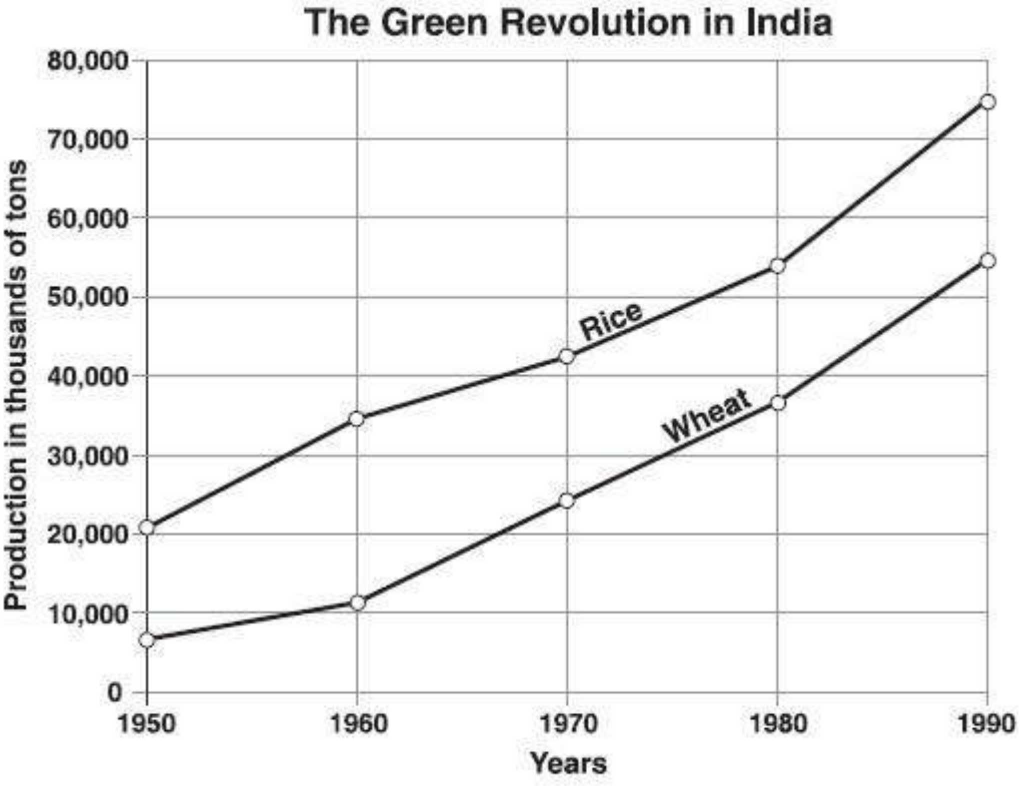
Green revolution had been a watershed in the history of Indian agriculture. It had blessed the nation with sufficient food grains that we had not witnessed any food crisis and still our Nation is self sufficient in food grains. The technology was input intensive and led to the incessant use of fertilizers, irrigation and pesticides. This has raised a serious concern in terms of the depleting resources. The depletion is in terms of the quality of soil, water and environment. This calls for the judicious and rational use of inputs. This is possible with the need based intervention in terms of input use. Artificial intelligence has the potential to realize need based intervention in agriculture. It has the potential to bring the second green revolution which will definitely need to be sustainable. In this paper we present the various applications of artificial intelligence to address the various harms caused by green revolution which will serve as broad guidelines to future work in agriculture.

Key words: Green revolution, input intensive, need based intervention, artificial intelligence, sustainable

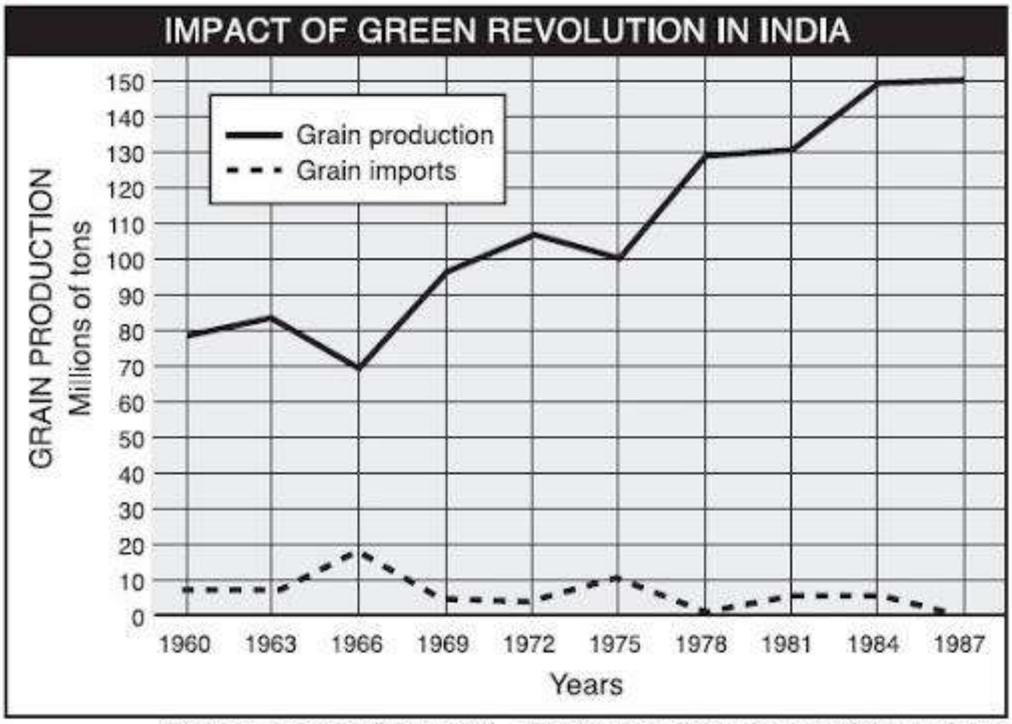
INTRODUCTION

Industrial revolution started in Europe in 18th to 19th century. It transformed the way in which the scale and time required for the production of commodities started taking place as compared to the pre-revolution era. The industrial revolution has progressed in the four phases. Each phase of revolution has seen invention which increased the pace of mechanization. In the first phase, it was in form of invention of steam engine. In the second phase, discovery of new sources of energy i.e. electricity, gas and oil along with the invention of automobile transformed the world. In the third phase, world has witnessed the transformation with the rise of electronics, telecommunications and computers. The fourth phase of revolution has seen the rise of internet and artificial intelligence. Artificial intelligence, as the term suggests is "*when the task is assigned to the machines and it accomplishes it with human behavior and rationality*". In other words, it is the capability of machines to imitate human behavior and solve problems much in the same way humans do. It has huge demand and applications in the field of finance, manufacturing, defense, security and healthcare. These are the sectors where the scale of production and intensity of mechanization has reached to the scale that permits the rapid intervention of artificial intelligence. Agriculture is also not untouched by this technology.

Along with the industrialization, agriculture has also seen the transformation all over the world. In India, the major transformation in agriculture had been in form of Green Revolution. It was the culmination of then prevailing conditions as the country suffered the setback of war with China in 1962, a huge import bill of the food grains and successive drought of 1965 and 1966. Green revolution started in 1965-66 with the introduction of High Yielding Varieties (HYV) in rice and wheat crop. This programme was introduced in the form of a package rather than an individual technology as the introduced high yielding varieties depended crucially on regular and adequate sources of irrigation, fertilizers, pesticides and insecticides. The increase in production was due to the high response of these introduced and adapted varieties to the enhanced levels of inputs. Higher production generated the marketable surplus, which transformed the subsistence nature of farming to the commercial one. This technology was responsible for the increased growth rate of food-grain output from 2.4% per annum before 1965 to 3.5% after 1965. Initially, the major increase in food production was due to increased production of wheat that increased from 50 million tonnes in 1950 to 79 million tonnes in 1964 and later to 95.1 million tonnes in 1968 (Bowonder, 1979). Since then, importing food grains has declined considerably.



Source: Library of Congress, Federal Research Division (adapted)



Source: James Killoran et al., *The Key to Understanding Global History*, Jarrett Publishing Co. (adapted)

This increase in production had made us self sufficient in the food grains. The later analysis of the Green revolution has brought many issues to the fore. The major socio-economic impacts of Green revolution had been in the form of inequity in its spread as it was more concentrated in North Western and Southern regions. The small farmers were not beneficiaries due to the poor economy of scale. The increase in the use of the chemical fertilizers has led to the pollution of agricultural lands, environment and water resources. The high yielding varieties were also susceptible to diseases compared to the landraces. These demanded the higher dose of chemical pesticides which has been polluting the atmosphere and poses serious health hazards to the farmer or labor working on the farm. These chemicals also accumulate in the harvest and impact the human health indirectly. The promotion of only rice and wheat had reduced the share of millets in the total production, which are comparatively superior in the nutrition. These all ill effects of the green revolution now demand a second green revolution which should be more equitable and sustainable.

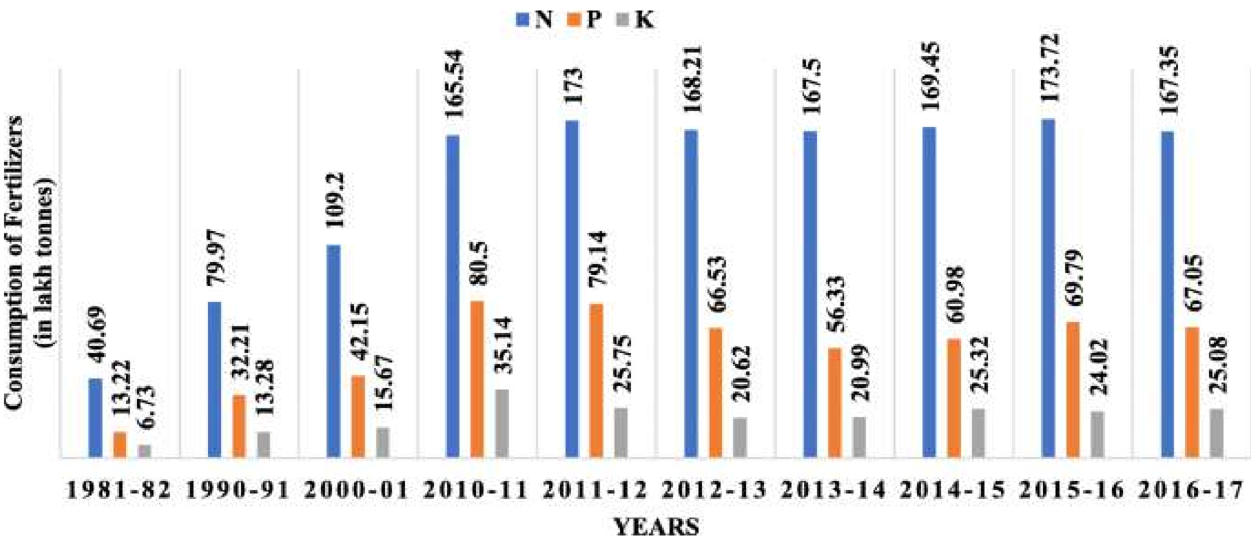
Though second green revolution will also have an intervention of technology in form of biotechnology and nano technology, it has to be sustainable in its approach. Need based intervention is the primary requirement which can pave the way for sustainability. This can be done through the use of artificial intelligence in agriculture. Artificial intelligence has the potential of not only reducing the manual intervention but can also reduce the ecological footprints and thus can enhance the sustainability.

Artificial intelligence has potential to change agriculture landscape of India

The broad areas where AI can be a booster tablet for Indian Agriculture are described as under.

SOIL ANALYSIS AND MANAGEMENT

After the introduction of high yielding varieties, there had been incessant use of fertilizers as the varieties were more responsive. The usage pattern of fertilizers is presented in the graph as below.



Consumption of fertilizers (N, P, and K) post-Green Revolution period (DAC&FW, 2017)

The Rice-wheat cropping system afterwards had become the dominant cropping pattern of the North India in particular, irrespective of its suitability to the prevailing soil conditions. Artificial intelligence has the potential to optimize the utilization of land. Soil can be analyzed with the help of remote sensing and photography in terms of its reaction, fertility status, depth, erosion susceptibility etc. This will pave the way for utilization of the land resources on the basis of its capability (Land Capability Classification as proposed by USDA). The soil can be managed for the erosion control and reaction. The knowledge of fertility status of soil is key to the optimization of the fertilizer use in soil. The technology can also be utilized for monitoring of the soil health. This will enhance the sustainability of the soil in long run.

AI-backed soil health monitoring used in Raleigh, North Carolina, USA, led to huge efficiency gains in the use of agro-inputs by cutting the use of chemical fertilizers by nearly 40%. (Sennaar, 2019)

WEATHER PREDICTION AND SOWING

Green revolution had been restricted to the irrigated areas in general and Northern and Southern India in particular. This is due to the fact that the HYVs are input intensive. There had also been the extension of area under agriculture. Now there is lesser scope of the increasing agricultural land. Therefore, it is pertinent to focus on rainfed and dryland areas in second green revolution which constitutes more than 65 per cent of the cultivated area. These areas are more dependent on the vagaries of nature, thus weather prediction plays an important role. As well accurate prediction of sowing time is important as the monsoon is more restricted and intense with respect to time in these areas. The weather prediction can be done with the help of machine learning algorithms and satellites. Daily weather prediction can also be done as per the need of the farming community of the particular area. AI can also be utilized to predict the time as well as method of sowing. Accurate prediction of sowing date can boost the yields of the rainfed areas. e.g. ICRISAT had collaborated with Microsoft in Andhra Pradesh wherein the farmers were alerted for suitable cropping dates, land preparation, and soil test-based fertilizer utilization and the crop yields gain were encouraging these areas.

IRRIGATION WATER MANAGEMENT

The high yield varieties introduced in green revolution were highly responsive to irrigation. The extension of irrigation had increased the productivity potential of the soil; however, excess irrigation has led to the increased level of ground water in these areas. This in turn has reduced the infiltration capacity of soil and increased the water logging susceptibility of land and consequent runoff. Soil salinity had also been observed in the green revolution belts. Hence, there is need to focus on efficient irrigation management in the second green revolution. This is also crucial when it is estimated that only 65 percent of net sown area will be under irrigation even after utilization of the complete ultimate irrigation potential.

AI along with the internet of things (IOT) can sense the timely and right moisture content of the soil and then can automate the irrigation system accordingly. Soil will continuously be maintained at the right moisture content as per the suitability of the crop, which will increase its yield. This will reduce the waterlogging of the field as well as will increase the water use efficiency. AI based irrigation holds potential for the dry farming areas, where focus is on increasing yield per unit of water used rather per unit land area.

AI tools can precise the input application

DECREASED PESTICIDE USAGE

It is estimated that in India, crop loss due to pests ranges from 25-35 per cent. HYVs though having high yield potential are more susceptible to the insect and diseases. Due to their short stature and lesser spreading nature, these are more susceptible to weed competition. It has promoted the use of pesticides in large quantities. There have also been the cases of development of resistant strains of weeds e.g. Isoproturon resistant strain of *Phalaris minor* in NW India. The use of pesticides has degraded the air quality, soil health and led to the ground water contamination in these areas. The accumulation of these pesticides in the harvested farm products has increased the chances of dreaded diseases (*e.g.* cancer) in human.

Keeping the above in view, it is pertinent that the second green revolution should focus on the judicious use of these chemicals. The detection of alien plant species (weeds) and pest infestation can be detected with the help of remote sensing and aerial photography. If the crop plant is having any insect and disease infestation, there will be change in its chlorophyll content and other pigments. Thus the Normalized Difference Vegetation index (NDVI) will have different values for these plants when compared to healthy one e.g. rice patches attacked by brown plant hoppers (*Nilaparvata lugens*) can be detected on the basis of NDVI indices. NDVI indices will also be helpful in determining the weed infested patches in the field. The estimation of spatial distribution of rainfall can help in the prediction of the specific pest incidence. Recently we have seen a resurgence of the locust swarms in Western and northern states of India. The advance estimate of the rainfall in the locust breeding areas can be helpful in their management in advance. Unmanned aerial vehicle (UAV) has been used in the large scale monitoring and management of the insect and pest incidence in crop fields. *e.g.* Microsoft has partnered with United Phosphorous (UPL), India's largest producer of agrochemicals, to create the Pest Risk Prediction App that again leverages AI and machine learning to indicate in advance the risk of pest attack. According to a Bloomberg report (2018), a project was undertaken by the Blue River Technologies (now under John Deere & Co.) to evaluate the effectiveness of AI-supported weed controlling technologies. The 'See & Spray' technology tested under this project in

Marianna, Arkansas, USA, reduced the expenditure on weedicides by around 90% reducing the need for weedicides used per acre from 20 to just 2 gallons (Little, 2018).

Unmanned aerial vehicle in operation

CROP DIVERSIFICATION

The green revolution was predominantly based on the improved varieties of rice and wheat. Post-Green Revolution, the area under cultivation increased from 97.32 million hectares in 1950 to 126.04 million hectares in 2014 (DES, 2014). The area under cultivation of coarse cereals decreased drastically from 37.67 million hectares to 25.67 million hectares since the 1950s. Likewise, the area under cultivation of sorghum decreased from 15.57 million hectares to 5.82 million hectares and that of pearl millet decreased from 9.02 million hectares to 7.89 million hectares (DES, 2014). But the area under the cultivation of rice, wheat, maize, and pulses increased from 30.81 million hectares to 43.95 million hectares, 9.75 million hectares to 31.19 million hectares, 3.18 million hectares to 9.43 million hectares, and 19.09 million hectares to 25.23 million hectares respectively (DES, 2014). The rise in the production of these crops has also led to the development of strong procurement policy (through large scale implementation of minimum support price) in favor of these crops. Along with the soil exhaustive nature of these crops, rice and wheat are also nutritionally inferior to the millets. Millets are rich in protein, vitamins and minerals.

There is an urgent need for the diversification of cropping system for environmental and nutritional security. The overall crop management with help of artificial intelligence tools (as mentioned above) will help in faster adaptations of changed cropping systems in these areas. The automated supply chains with the help of AI tools will definitely ease the marketing hurdles for the harvest of changed cropping systems and will increase the profit margin of farmers. It can also be utilized for the demand forecasting and then synchronization it with the supply of farm products will also reduce the price burden of consumers.

Jivabhumi's 'Foodprint' is a produce aggregation and food traceability solution which aggregates the farm produce, provides e-marketplace services and implements traceability. It claims to use technologies such as blockchain to capture the information of the produce at various levels in the supply chain.

CONCLUSION

In recent times the whole world is going through an unprecedented crisis in the form of Corona virus. It has forced the increased penetration of technology and automation in every sector of economy. In India, we have seen its impact in MSME and other service sector, where lot of peoples were employed, far from their native states. These labourers have migrated to their native villages. Now it becomes a huge challenge to absorb this workforce and provide them livelihoods. Making agriculture more profitable and attractive can prove a remedy to this. Government has also declared the support to agriculture through capital infusion and various reforms. However, these reforms are needed to be technology backed. Artificial intelligence is not only a short term solution to these immediate problems but also towards the long term problem of ecological, economic and social sustainable.

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"Farmers' suicide in India: Current scenario"

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Abstract
The purpose of the study is to examine the current scenario of farmers' suicide in India. Farmer suicides in India refer to the national catastrophe of farmers committing suicide since the 1990s. The farmers' suicide rate in India had ranged between 1.4 and 1.8 per 100,000 total population, over a 10-year period through 2005, however the figures in 2017 and 2018 showed an average of more than 10 suicides daily. In this way, present study depicts about what NSSO and NCRB data 2018 says about farmers' distress in India has been discussed.
Keywords: Farmer's suicide, Agrarian Distress, Sustainable Development, Irrigation, Agrarian crisis

I.BACKGROUND:

"Suicides by farmers today are actually a symptom of a much wider crisis in India's farm and agricultural sector," P. Sainath.

The Indian farmers, the largest body of surviving small farmers in the world, today faces a crisis of extinction. Two thirds of India makes its living from the land. The earth is the most generous employer in this country of a billion that has farmed this land for more than 5000 years.

In India agriculture is a state subject it means the main responsibility of development of agriculture lies with the state only and the centre can provide resources to states to develop primary sector. under DPSP (Directive Principles of State Policy) Our Constitution also says that it is the duty of the state to develop agriculture, articles 38 and 48 justifies this Article 38(2) says that the state shall, in particular, strive to minimise the inequalities in income, and endeavor to eliminate inequalities in status, facilities and opportunities, not only amongst individuals but also amongst groups of people residing in different areas or engaged in different vocations. Another article vividly mentions that the state shall endeavour to organize agriculture and animal husbandry on modern and scientific lines and shall, in particular, take steps for preserving and improving the breeds. No nation can afford to compromise with its farming and farmers. And much less India, wherein the absolute number of households engaged in agriculture in 2011 (119 million) outpaced those in 1951 (70 million).Then, there are the landless agricultural labour who numbered 144.30 million in 2011 as against 27.30 million in 1951. The welfare of this elephantine size of India's population is predicated upon a robust agricultural growth strategy that is guided by an income enhancement approach.

However, as farming is delinked from the earth, the soil, the biodiversity, the climate and linked to global corporations and global markets, and the generosity of the earth is replaced by the greed of corporations, the viability of small farmers and small farms is destroyed. Farmers suicides are the most tragic and dramatic symptom of the crisis of survival faced by Indian peasants.

1997 witnessed the first emergence of farm suicides in India. Rapid increase in indebtedness was at the root of farmers taking their lives. Debt is a reflection of a negative economy, a loosing economy. Two factors have transformed the positive economy of agriculture into a negative economy for peasants – the rising costs of production and the falling prices of farm commodities. Both these factors are rooted in the policies of trade liberalization and corporate globalization.

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Farmer suicides has turned out to be a major socioeconomic concern in India that has resulted in profound implications on the quality life of farmers. According to the United Nations Commission on Sustainable Development (UNCSD), one farmer committed suicide for every 32 minutes between 1997 and 2005 in India. A total of 3,32,603 farmers (2,84,008 males and 48,595 females) committed suicide between 1995 and 2018.

II. REVIEW OF LITERATURE:

Ambedkar, D. B. (1918):"In short, strange as it may seem, industrialization of India is the soundest remedy for the agricultural problems of India. The cumulative effects of industrialization, namely a lessening pressure (of surplus labour) and an increasing amount of capital and capital goods will forcibly create the economic necessity of enlarging the holding. Not only will this, but industrialization, by destroying the premium on land, give rise to few occasions for its sub-division and fragmentation. Industrialization is a natural and powerful remedy, in this paper Ambedkar strongly suggested the ideas of Arthur Lewis theory of Theory of economic development which suggests that in order to develop a

Posani, B. (2009):- Desperate indebtedness was found to be the common thread that ran through most of the reported suicides. Deeper analyses, however, reveal that indebtedness is only a symptom. According to this report the major causes for Agrarian Distress in India are small land holding, less institutional support, declining irrigation facility, relying more on mansoon, price shocks, credit squeeze, trader- money lender Nexus and pervasive indebtedness. Indian agriculture today is 'the economic residue' that accommodates 'non-achievers', and that the principal motivation of the peasant today is to stop being a peasant Not an encouraging prospect, then, for the peasant movements, or the peasant.

Saritha, G. (2015): reviewed that the between 1997-2007 21,174 farmer's suicide reported in India, the major reason is indebtedness. In their case study they figured out these following results, the outbreak of suicide in India is appalling and on average one Indian farmer committed suicide every 32 minutes during the past period 1997to2007 and as many as 48 farmers suicide per day in India between 2002-2007. The farmer suicide in India as a clear indication of serve distress in the farming community. The causes for present agrarian distress vary from one to another state. But the genuine causes may be common in all states which include external trade liberalization and neo-liberal policy driven reforms in the economy have played havoc with the farm dependent population in the country. Indian state now acknowledges the fact that between 1993and2003, 1, 00,248 farmers committed suicide in India..The most important factor is debt.

Vasavi, A. (2005): focused on the relationship between commercial crops and suicides. Since the key sources of non-institutional creditors have been agri-business agencies (who provide both inputs at deferred credit to agriculturists and loans), and the new money lenders and creditors13, including relatives and friends who draw on their urban salaries, these debts pose a double burden on agriculturists. For one, interest rates are exorbitant (ranging from 24 to 45 percent per annum) and secondly they are linked to their personal and social networks. Inability to pay is often met with ridicule, ostracism or public humiliation. As several reports and case studies highlight, many of those who committed suicide did so after experiencing such humiliation or facing threats of dispossession of their assets.

Based on the above mentioned reviews the research gap has been found on the farmers' suicide. Hence the study has been made as follows.

III. DISCUSSION

A total of 10,349 persons involved in farming sector (consisting of 5,763 farmers/cultivators and 4,586 agricultural labourers) have committed suicides during 2018, accounting for 7.7 per cent of total suicides in the country. Also it is found that out of 5,763 farmer/cultivator suicides, a total of 5,457 were male and 306 were female during 2018. Out of 4,586 suicides committed by agricultural labourers during 2018, 4,071 were male and 515 were female.

Figure 1.1. : Percentage Distribution of Suicide Victims by Profession during 2018 (All India)

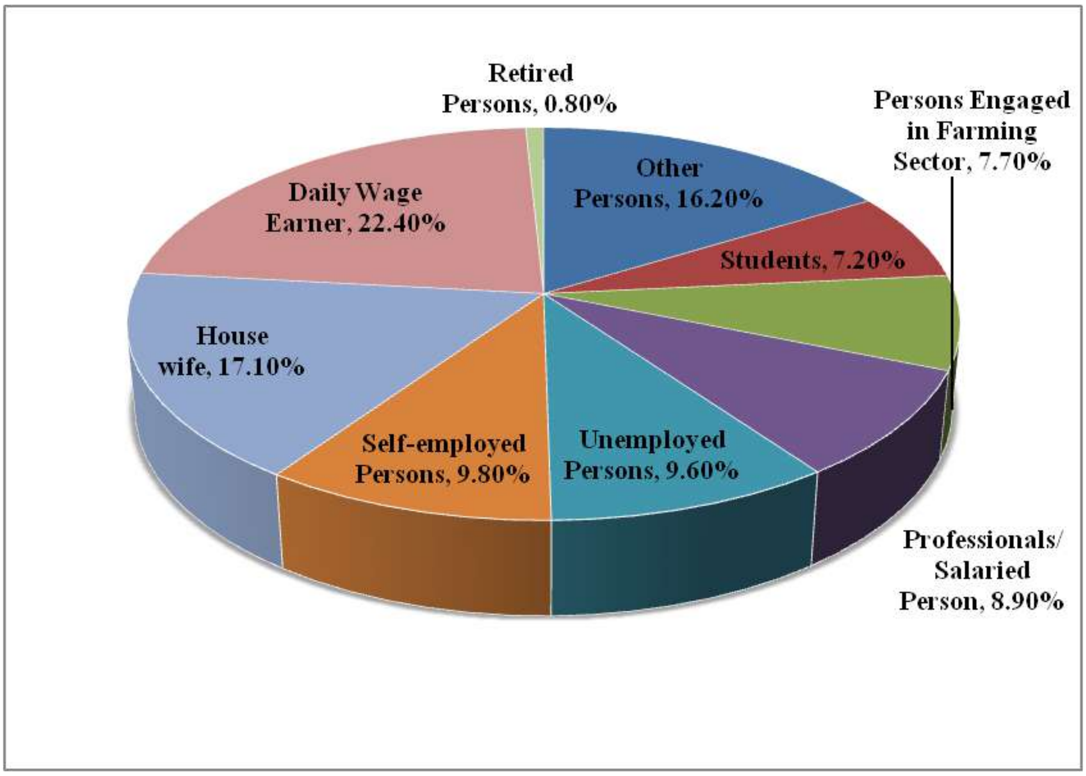
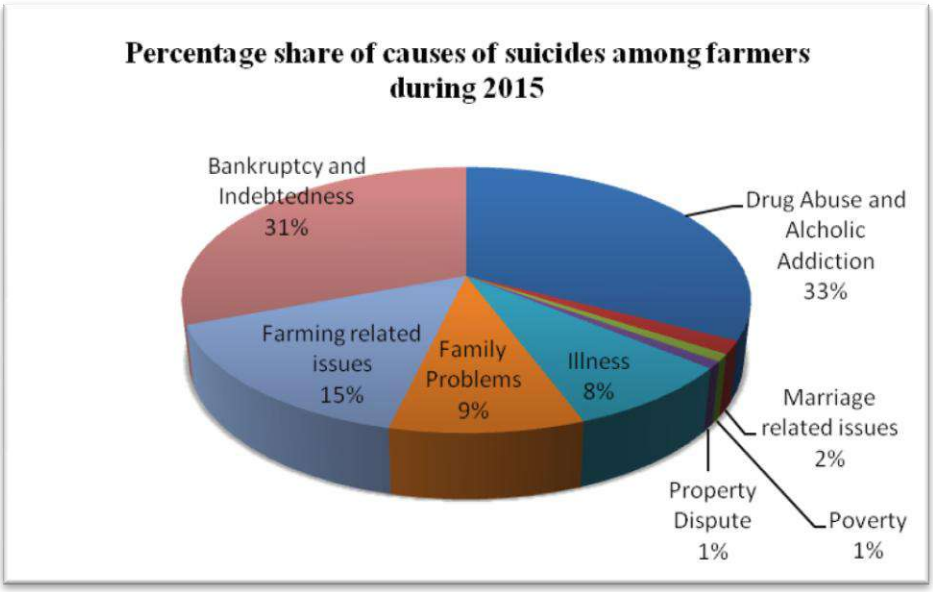


Table 1 Persons Engaged in Farming Sector Suicides during 2018 (All India)

Profession	Male	Female	Transgender	Total	Percentage Share
1. Farmers/Cultivators	**5457**	**306**	**0**	**5763**	**4.3**
a) who cultivate their own land with or without assistance of agricultural labourers	4848	240	**0**	5088	3.8
b) who cultivate on leased land/work on lease/on other's land (known by different nomenclature) with or without assistance of agricultural labourers	609	66	**0**	675	0.5
2.Agricultural Labourers	**4071**	**515**	**0**	**4586**	**3.4**
Total	**9528**	**821**	**0**	**10349**	**7.7**

Reasons for farmer suicides in India (NCRB, 2015)

The decision to commit suicide by the victim cannot be attributed to a single reason. It was spur- of-the-moment triggered action with respect to 70 to 80 per cent of victims. The final action of committing suicide was a combination of several cumulative causes which can be grouped into social, farming and debt-related.



Various reasons have been offered to explain why farmers commit suicide in India. Farmers feel a repeated sense of hopelessness due to the loss of crops, income and land. Another factor that increases suicides is the social isolation due to the loss of communities as well as geographical remoteness. The prominent causes recognized for farmer suicides were bankruptcy or indebtedness, family problems, farming related issues, illness and drug abuse/alcohol addiction.

Table: Farmers Suicides during 2018 (State & UT - wise)

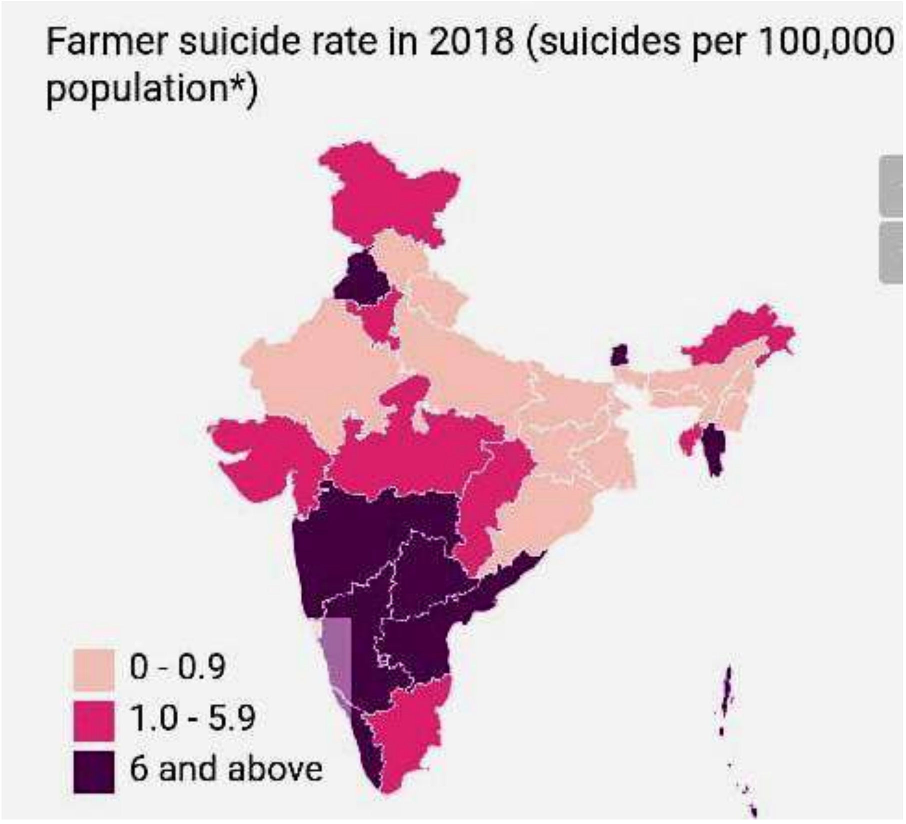
Sr No	**STATES**	**Male**	**Female**	**Trasnsgender**	**Total**
1	ANDHRA PRADESH	593	71	0	**664**
2	ARUNACHAL PRADESH	4	0	0	**4**
3	ASSAM	52	3	0	**55**
4	BIHAR	0	0	0	**0**
5	CHHATTISGARH	440	27	0	**467**
6	GOA	0	0	0	**0**
7	GUJARAT	117	15	0	**132**
8	HARYANA	91	13	0	**104**
9	HIMACHAL PRADESH	17	0	0	**17**
10	JAMMU & KASHMIR	24	2	0	**26**
11	JHARKHAND	43	15	0	**58**
12	KARNATAKA	2232	173	0	**2405**
13	KERALA	197	14	0	**211**
14	MADHYA PRADESH	643	12	0	**655**
15	MAHARASHTRA	3360	234	0	**3594**
16	MANIPUR	2	0	0	**2**

17	MEGHALAYA	0	0	0	**0**
18	MIZORAM	14	3	0	**17**
19	NAGALAND	2	0	0	**2**
20	ODISHA	0	0	0	**0**
21	PUNJAB	317	6	0	**323**
22	RAJASTHAN	20	0	0	**20**
23	SIKKIM	8	1	0	**9**
24	TAMIL NADU	303	98	0	**401**
25	TELANGANA	801	107	0	**908**
26	TRIPURA	7	3	0	**10**
27	UTTAR PRADESH	230	24	0	**254**
28	UTTARAKHAND	0	0	0	**0**
29	WEST BENGAL	0	0	0	**0**
	TOTAL (STATES)	**9517**	**821**	**0**	**10338**
	UNION TERRITORIES				
30	A & N ISLANDS	4	0	0	**4**
31	CHANDIGARH	0	0	0	**0**
32	D & N HAVELI	7	0	0	**7**
33	DAMAN & DIU	0	0	0	**0**
34	DELHI (UT)	0	0	0	**0**
35	LAKSHADWEEP	0	0	0	**0**
36	PUDUCHERRY	0	0	0	**0**
	TOTAL (UTs)	**11**	**0**	**0**	**11**
	TOTAL (ALL INDIA)	**9528**	**821**	**0**	**10349**

(Source: ADSI report, 2018)

The rising spate of farmer suicides in different parts of India is not a new phenomenon. According to the recently released Accidental Deaths & Suicides in India (ADSI) report, 10,349 farmers committed suicide in 2018, accounting for 7.7 per cent of the total number of suicides in the country. Many states and union territories have reported nil data on suicides by farmers, cultivators and farm labourers.

Majority of suicides were reported in Maharashtra (3594) followed by Karnataka (2405), Telangana (908), Andhra Pradesh (664) and Madhya Pradesh (655) respectively. In other words Maharashtra accounted for the highest share in farm-related suicides at 34.7%, followed by Karnataka at 23.2%, Telangana 8.8%, Andhra Pradesh 6.4% and Madhya Pradesh at 6.3%, data showed. West Bengal, Bihar, Odisha, Uttarakhand, Meghalaya, Goa and Union territories, including Delhi, reported zero suicides by farmers/cultivators and agricultural labourers.



Farmer suicides in India refer to the national catastrophe of farmers committing suicide since the 1990s. The farmers suicide rate in India had ranged between 1.4 and 1.8 per 100,000 total population, over a 10-year period through 2005, however the figures in 2017 and 2018 showed an average of more than 10 suicides daily. There are accusations of states manipulating the data on farmer suicides, hence the real figures could be even higher. Some states seem to barely have a farmer suicide issue, the NCRB data suggests. In 2018, six states, including Bihar, Odisha, and West Bengal reported zero farmer suicides. However, for states such as Odisha and West Bengal the claim of zero suicides seems implausible. In Odisha, ground reports of farmer suicides, including data presented in the assembly, do not match NCRB data.

According to a report by the National Crime Records Bureau, the states with the highest incidence of farmer suicide in 2015 were Maharashtra (3,030), Telangana (1,358), Karnataka (1,197), Madhya Pradesh (581), Andhra Pradesh (516), and Chhattisgarh (854).

Factors like inadequate irrigation facilities, changing cropping patterns, low return from the farm sector, inadequate agricultural infrastructure, poor agriculture-related marketing policies, and insufficient public investment for agrarian development exacerbated farmer suicides. Additionally, external factors such as excessive economic liberalisation, low import tariffs, widening disparities between agriculture and non-agricultural sectors, dumping of agricultural goods in global markets are also to blame

Apart from these factors, farmer suicides in a particular region are directly linked to the vulnerability of that region to extreme weather events, such as droughts and floods. These extreme climatic events increase the risk of crop failure. States like Karnataka, Maharashtra, Kerala, Andhra Pradesh, Madhya Pradesh, and Gujarat, that reported relatively higher numbers of farmer suicides, have a higher percentage of drought-prone areas and lesser flood-prone ones.

Tamma Carleton, a researcher at the University of California at Berkeley, compared suicide and climate data, concluding that climate change in India may have "a strong influence" on suicides during the growing season, triggering more than 59,000 suicides in 30 years. More than 23,000 farmers have committed suicide in the state of Maharashtra between 2009 and 2016.

IV. CONCLUSION:

India is an agrarian country with around 70% of its people depending directly or indirectly upon agriculture. Farmer suicides are an unfortunate result of the agrarian distress plaguing the rural economy of many states of the country. There are many reasons found on farmers' suicide, apart from internal and external factors, it is also found that climate change causes bad weather and erratic monsoon triggering more suicides in last 30 years. Thus, the problem needs to be tackled by helping agriculturists in suicide-prone areas in a way that would build productive and marketing capabilities. Also Adequate attention on yield, price, credit, as well as weather, health, life, crop and cattle insurance, besides improving water availability, rural electrification and timely intervention of a procurement mechanism needs to arresting the suicide death toll among farmers.

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Application of ultrasonography in mare reproduction

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Ultrasonography has been demonstrated to be a technological breakthrough in the diagnostics of modern assisted reproduction. Ultrasonography offers several advantages as a technique for rapid non-invasive evaluation / visualization of reproductive organs as compared with other invasive techniques like endometrial biopsy, endoscopy and transvaginal palpation. Ultrasonography in the veterinary profession has gained significant value in the gynecological examination of mares and in contrast to rectal examination, which permits a much earlier and more accurate diagnosis of pregnancy and provides relevant practical information about many other conditions of the genital tract.

APPLICATIONS OF ULTRASONOGRAPHY

Follicular dynamics and ovulatory status for covering / Artificial Insemination (A. I.).

Follicles: Ultrasound is a more sensitive method for detecting and measuring ovarian follicles especially, those within the ovarian stroma. The average length of estrus duration in mares is 4-7 days (Robert, 1971). While conducting the teasing, the interest of the teaser in the mare gives a hint that the mare is in heat. On examination per rectal, first day of the oestrus, the size of the growing follicle (graffian follicle) would be 15-25 mm with slight softness. The size and softness of graffian follicle increases gradually during the estrus period as the time of ovulation approaches. By the 5 and 6th day of estrus, the graffian follicle attains the size of 40-45 mm along with increased softness. Ultrasonography will reveal the size of the developing graffian follicle and will also reveal if there is development of two graffian follicles. Increase in the size along with increase in softness of the graffian follicle gives a hint, which is useful in predicting ovulation within a period 24 hours. Ovulation is detected by ultrasonography as the acute disappearance of large follicle (40-50 mm) that was present at a previous examination (Fig. 1).

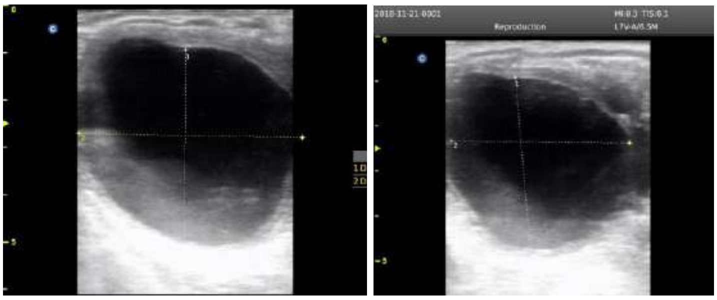

Fig. 1. Mature graafian follicles.

Corpus luteum : The ultrasonic detection and evaluation of corpus luteum (CL) provide valuable information to the diagnostician and biologist. The presence and stage of the luteal gland cannot be ascertained readily during the developing and regressing stages by per rectal palpation.

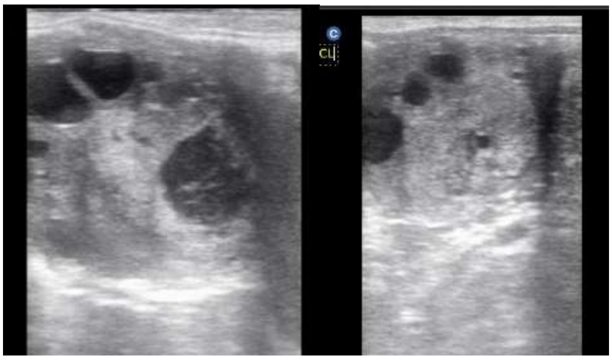

Fig. 2. Corpus Lutea on the ovary.

Early Pregnancy Diagnosis (Cyesiognosis): Early diagnosis of pregnancy with ultrasound is highly accurate around 14-16 days post covering / A.I. Gary England, (2005). In equines early pregnancy diagnosis is most important especially in the case of a mare which remained empty, as she can be covered in the subsequent cycle, thus avoiding economic loss. Pregnancy diagnosis can be made as early as 14-15 days of the conception. Ultrasonographically, a non-echogenic (black), spherical zone confirmation of the early conceptus, is a peculiarity of the horse and the human being which makes such an early positive diagnosis possible (Day 14 post ovulation in the mare and Day 20 in the human). The location of the embryonic vesicle in the mare was found to be constant (in one horn near the body junction) which made it possible to detect the conceptus within a minute after insertion of the rectal probe. In this regard, in making an early pregnancy diagnosis (before Day 15 or 16), it is essential that the entire uterus be scanned, as the vesicle can be located anywhere within the uterine lumen during mobility phase upto days seventeen. Fetal membranes in equines develop in a pattern that permits an accurate estimation of the stage of gestation by ultrasonography, until 45 days after ovulation. With a 5.0 MHz transducer, the yolk sac may first be seen as a spherical anechoic embryonic vesicle in uterus at 9 to 10 days. It is > 4 mm in diameter. The early conceptus (yolk sac) has a bright white (echogenic) line on the dorsal and sometimes on the ventral aspect of its image caused by specular reflections. This characteristic is helpful in differentiating an embryo from some uterine cysts. From day 10 to 16, the motile round anechoic conceptus is detectable in the uterine lumen. The conceptus frequently has a characteristic triangular shape on Day 17 to 21. At Day 21 the embryo can be seen as a small echogenic mass in the ventral aspect of the yolk sac.

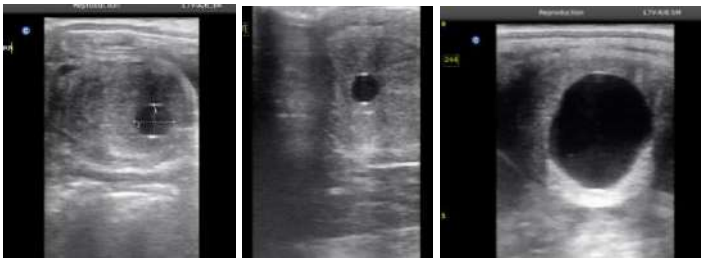

Fig. Pregnancy determination at various stages in mares.

Early Detection and Timely Management of Twins: In the mares two per cent of all pregnancies start as twin conceptions but consequently end in economic failure due to abortion. Delivery of two foals also places the mare at great risk for trauma and damage of the reproductive tract and can even result in the death of the mare (Ginther, 1986). Ultrasonography is of great help in the early detection of twin pregnancy and crushing of one pregnancy, and as such also extremely helpful to prevent subsequent breeding complications, and to improve reproductive efficiency. Rupture of one conceptus if performed before 28-30 days of gestation has approximately a 90 per cent success rate in yielding a live foal. The smaller vesicle should be crushed at the tip of one uterine horn by monitoring with ultrasonograhy between 14 to 16 days, because after day 16 the conceptus gets fixed at the base of one uterine horn (Ginther, 1986). If fixation has occurred, one embryo can be ruptured by the direct compression of the conceptus with thumb and fingers. After 30 days management of twins becomes less successful by manual rupture (Ginther, 1986).

Fig. Twin pregnancy in mare.

Determination of Foetal viability, growth and development: The size of the vesicle can be measured by freezing the images on screen. Until approximately day 16, the vesicle grows at a rate of 3 to 4 mm per day. From days 16 to 28, there is a plateau in the growth of the vesicle and then growth resumes at a slightly slower rate. The embryo within the vesicle can be detected ultrasonographically by day 20 or 21 and its heartbeat can be detected by day 22. The size and shape of the early vesicle are diagnostically important in estimating the age of conceptus, particularly when exact breeding dates are unknown.

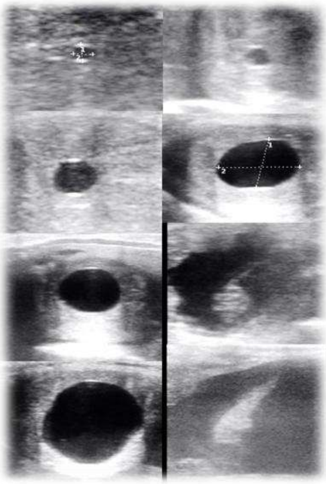

Fig. Determination of fetal webeing at different stages of pregnancy.

Diagnosis of Early Embryonic Death (EED) / Foetal resorption : Early embryonic death results in low reproductive efficiency of equids (Ball and Woods, 1987). Early embryonic death is diagnosed when an embryonic vesicle is found to be irregular, contains fluid in the uterine lumen, echogenic vesicular fluid, no fetal heart beat and slow vesicular growth than normal (Ginther et al., 1985).

Equine fetal gender determination: This technique is extremely useful for the determination of the sex of the fetus and can be made accurately on 57-70 days of pregnancy in mares Bucca, (2005). The technique involves the identification of the genital tubercle, the precursor of the penis in the male and the clitoris in the female. Around day 55, the genital tubercle appears as a hyperechoic equal sign (=), located between the fetal hind limbs, approximately an equal distance between the tail and umbilical cord. As the gestation progresses, the genital tubercle migrate towards the tail in the female fetus and towards the umbilical cord in the male (genital tubercle is a bilobed structure approximately 2 mm in diameter). After day 70, it may not be possible to view the entire fetus for adequate determination of genital tubercle location. Successful determination of fetal sex using ultrasound requires proper timing of examination, a skilled examiner, high quality equipment and of course, the cooperation of the mare.

Miscellaneous application of ultrasonography: Ultrasonography has also been used in many more area of reproductive disorders like lack of ovulatory follicles / silent ovulation, prolonged luteal activity, anovulatory haemorrhagic follicles and ovarian haematomas, ovarian tumours, intraluminal free fluid, pyometra / endometritis, Pnemovagina / air in the uterus, and neoplasis / abcesses / Haematomas.

CONCLUSION

It is thus becoming apparent that ultrasound diagnostic in veterinary medicine may experience the same kind of development as it has in human medicine where it was first applied in gynaecology at the end of the fifties and since then has expanded into virtually all fields of diagnosis. Although the technique only stands at the beginning of its development in veterinary medicine, it is obvious that ultrasound imaging provides a valuable additional diagnostic technique in gynaecological and obstetrical examinations. In the few years of its application, this technique has already provided several new indications for diagnostic examinations in normal and pathological conditions of the genital tract and other organs of body of domestic animals. When compared to conventional methods the diagnostic accuracy has improved significantly, too.

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Biotechnological Role in Pulses Crop Improvement

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Pulses are the cheapest source of protein and therefore, occupy an important position in balancing human dietary needs. Furthermore, pulses enrich soil fertility by adding nitrogen to the soil and also improve soil structure by their deep root system. There are several reasons for stagnation in pulse production *viz.,* narrow genetic base, susceptibility to large number of biotic and abiotic stresses, photoperiod sensitivity and low native nutritional value. There is an urgent need to increase the productivity of pulses and enhance nutritional value in number of pulse crops. Unfortunately, conventional methods of crop improvement have not been able to keep pace with the need of the time, apparently due to long gestation periods, undesirable linkages and lack of reliable resistant donor lines. Thus, the successful augmentation of traditional approaches to plant breeding based on advances in applied biotechnology has assumed utmost significance and considered crucial for future realization of yield potential and value addition. Similarly, identifying novel genes and assessing their suitability as candidate genes for genetic engineering options will be important for future breeding programs in order to achieve remarkable impacts in these grain legume crops globally. This review mainly provides a comprehensive picture of the different biotechnological interventions adopted for addressing various constraints in gain legume productivity and improvement, highlighting the pitfalls and possible solutions that can be taken through an integrated approach to combat the altered environmental conditions. Application of biotechnology in legume improvement is likely to bring about profound changes in the following areas:

- Accelerating progress by shortening the breeding cycle
- Eliminating linkage drag associated with conventional breeding approaches
- Transferring genes transcending taxonomic boundaries to overcome pest and disease constraints and nutritional value addition
- Enhancing gene bank and biodiversity management using molecular tools

GENETIC MAPPING AND QTL ANALYSIS

The complex genetic nature of inheritance to abiotic stress tolerance traits such as drought, salinity, and low temperature and the difficulty of phenotyping for such traits under field conditions along with high genotype × environment interactions were initially daunting. More recently, the ability to identify quantitative trait loci markers for polygenic traits has expanded marker-assisted breeding. The repertoire of molecular markers has grown considerably over the years from the tedious RFLP types to the more versatile RAPD and AFLP type markers. However, nowadays SSR, SNP, and DArT markers have become widely accepted for use. In leguminous crop breeding, these varieties of markers have been employed with varying combinations for biotic as well as abiotic stress tolerance selection, more success being achieved for biotic stress MAS as in soybean for resistance against cyst nematode or for resistance against common bacterial blight in pinto bean. Nonetheless, there have been successful reports of MAS for abiotic stress tolerance or toward achieving that goal by way of identification of QTL. For example, selection for drought-tolerant common bean genotypes has been shown using five RAPD markers with improved performance under stressed conditions. In cowpea, QTL associated with drought response phenotypes were identified. Similarly, root trait QTL for drought avoidance were identified in chickpea and will likely contribute to expedite development of varieties for enhanced drought avoidance. It is foreseen that in the next 5 years with major QTL being identified for abiotic stresses in pulse crops, the relevance of pyramiding and QTL introgression will increase dramatically.

In chickpea, a hot spot region that affects several traits (root length density, root biomass, and shoot biomass) contributing to drought tolerance has been identified from two mapping populations (ICC 4958 × ICC 1882; ICC 283 × ICC 8261) segregating for root traits. This region contributes up to 36% of phenotypic variation in both root and shoot biomass and root length density. Terminal drought is the major constraint to chickpea productivity, particularly in the semiarid tropics where it is generally grown rainfed on residual soil moisture after the rainy season. Root traits, particularly rooting depth and root biomass, are known to play an important role in drought avoidance through more efficient extraction of available soil moisture. Marker-assisted breeding for root traits is expected to improve precision and efficiency of breeding for drought tolerance.

TRANSCRIPTOMIC RESOURCES

Gene expression profiling approaches had tremendous impact on obtaining global snapshots of genes under any particular condition of plant growth, be it spatial, temporal, developmental, or environmental. Several efforts have been made to generate marker resources, linkage and physical maps and quantitative trait loci in pulses. However, only a few studies have been performed to generate functional genomic resources in chickpea. Although quite a few studies have been conducted to identify the genes involved in drought and salinity tolerance in chickpea, they were focused mainly either on a single genotype and were limited by throughput. Further, data analysis was not comprehensive due to non-availability of the reference transcriptome sequence. Overall, they failed to provide a genome-level understanding of transcriptional responses under abiotic stresses. Recently, genome-wide identification of stress-responsive genes using RNA-seq in chickpea, but this study also focused on a single genotype. However, it has been realized that comparative differential gene expression analysis between genotypes with contrasting response to the stresses can provide a better understanding of the molecular mechanisms underlying tolerance and provide better candidate genes.

Transgenic Approaches

Transgenic approaches, as controversial as they may be, offer perhaps one of our fastest means for the development of abiotic stress-tolerant pulse crops. However, the transgenic technology can also complement functional genomics studies to validate expression of cloned genes related to abiotic stress tolerance. In pulse crops, both in vitro culture and genetic transformation were slow to be developed. The availability and versatility of different DNA delivery methods are becoming important for pulse crop improvement, since transcriptomic resources are becoming increasingly available. Furthermore, although sequences of known functions in the databases can be used for homology-based prediction of gene function of unknown sequences, more precise functions of the genes of interest are often difficult to ascertain, except by a transgenic approach. Therefore, the availability of high-throughput gene transfer systems for economically important pulse crops has become highly necessary for rapidly assessing gene function. The electroporation-mediated transformation of nodal axillary buds of pea, cowpea, and lentil and production of transformed plants are encouraging for further refinement of this strategy for transforming pulse crops.

In Vitro Regeneration and Transformation

Notwithstanding the recalcitrance of pulse crops to tissue culture and transformation, there are many successful reports. In vitro culture as such, prior to being a target for use in transformation, was used for embryo rescue in wide hybridizations and for in vitro selection. For example, interspecific hybrids of lentil were rescued by embryo culture. Similarly, hybrid plants from a cross between *P. vulgaris* L. and *P. lunatus* L. were obtained by embryo rescue and confirmed by rDNA analysis. In chickpea, although limited success for interspecific hybridization and embryo rescue was initially encountered, some success has been obtained. Embryo rescue was also used to produce hybrids between *Cajanus platycarpus* × *C. cajan.* Considering that tolerance to abiotic stresses exists in many wild species of pulse crops, hybridization between cultivated species and their wild counterparts, followed by embryo rescue, is likely to be a strategy worth exploring. ICRISAT has taken a leading role in recent years in improving mandated pulse crops for abiotic stress tolerance, especially drought tolerance, and include use of genetic transformation technology.

Next-generation sequencing (NGS)

It is the most recent technological addition to expediting genome sequencing. Genomic sequencing information is valuable for different purposes such as gene identification and molecular marker development in varieties of interest. With the availability of a reference genome as in Medicago, single nucleotide polymorphism (SNP) markers can be developed for other varieties. Even if a reference genome is not available, NGS can be performed. For example, in chickpea, using Solexa tags of root tissues of drought tolerant and drought-sensitive genotypes, 5.2 and 3.6 million reads, respectively, were generated, with the identification of about 500 SNPs. Chickpea transcriptome has also been sequenced with short reads on Illumina Genome Analyzer platform and will be valuable for marker development and gene identification. The role of small RNAs in posttranscriptional regulation of gene expression is now well established, including their roles in abiotic stress tolerance. A few encouraging reports have recently shown the roles of miRNAs in abiotic stress tolerance in pulse crops. For example, cowpea miRNAs have been identified and their potential roles in salinity stress tolerance due to differential expression in roots have been shown. Stress responsive miRNAs were also identified in common beans subjected to nutrient deficiency stress and manganese toxicity.

Comparative genome mapping and synteny analysis

Comparative genome mapping harnesses conserved/similar sequences and syntenic associations across diverse as well as related genomes. Special emphasis has been placed towards generation of functionally-relevant molecular tools in almost all the major crop species. Importantly, in order to gain accurate estimates of adaptive variation, emphasized on measurement of genetic diversity using genic markers. Due to the lack of adequate supply of DNA markers, EST-SSR markers from closely related legume species like Medicago, soybean, common bean and cowpea were successfully applied for diversity estimation, genetic linkage mapping and QTL analyses (Almeida *et al.,* 2014).

Similarly, the extent of microsynteny was assessed between genomes of *L. angustifolius* and soybean using entire sequences of two *L. angustifolius* BAC clones. The structural similarity in chloroplast genomes and variability in mitochondrial DNA were apparent from a comparative study made between these two species, and with the model plant species i.e. Lotus japonicus and Arabidopsis thaliana (Naito *et al*., 2013). Besides uncovering the genomic regions that remained stable across different phylogenetic lineages, comparative analysis envisages chromosomal rearrangements like deletion/insertion, and duplication events.

Reverse genetics tools

Reverse genetics comprises a suite of approaches including the transgenic techniques and nontransgenic methods like targeting induced local lesions in genomes (TILLING). In legume crops, TILLING populations have been slow to be created.

However, in recent years, TILLING populations have been produced for major pulse crops. Therefore, TILLING populations for pulse crops will be very valuable to mine for abiotic stress genes. Legumes are the founder food-crops in which commercial benefits of transgenic technology were reaped. Examples include worldwide cultivation of herbicide tolerant Roundup Ready (RR®) soybean and increasing global acceptance for RR® alfalfa. The advances in genetic transformation systems in major grain and forage legumes have recently been reviewed by Atif *et al.* (2013).

CONCLUSIONS

Biotechnology approaches have the potential to enhance crop production under different stress conditions. On the one hand, abiotic stresses are complex in nature; on the other hand, there are several challenges that have restricted the realization of the full potential of using biotechnology approaches in crop breeding. Nevertheless, with current and fast emerging technologies such as RNAi, targeted gene replacement using zinc-finger nucleases, chromosome engineering, MARS and GWS, NGS and nano biotechnology, the future seems bright with respect to the development of designer crops with improved features that can use natural resources such as water, soil nutrients, atmospheric carbon and nitrogen with a far greater efficiency than ever before. Rich databases of genome sequences/haplotypes, phenotypes, marker trait associations may facilitated legume breeders to select the parental lines and consider different crossing schemes, so that superior lines with enhanced resistance to diseases and tolerance to abiotic stresses with other market quality traits can be generated.

Future prospects

It can be anticipated that coming years will be more exciting for integrating GAB tools and approaches in conventional breeding programs. While generating sequence or genotyping data is expected to be trivial, the legume scientists need to work on precise and cost-effective phenotyping and developing the decision support tools and breeders-friendly databases to ensure undertaking integrated breeding approaches for crop improvement.

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Aflatoxicosis: Its Effect, Prevention In Animals, Birds And Zoonotic Potency To Human Beings

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ABSTRACT
Aflatoxins are toxic metabolites produced by certain fungi in foods and feeds. They are probably the best known and most intensively researched mycotoxins in the world. Aflatoxins have been associated with various diseases, such as aflatoxicosis, in livestock, domestic animals, birds and humans throughout the world. The occurrence of aflatoxins is influenced by certain environmental factors. Aflatoxins have received greater attention than any other mycotoxins because of their demonstrated potent carcinogenic effect in susceptible laboratory animals and their acute toxicological effects in humans. The clinical signs are often non-specific, and chronicity is often the rule. The practicing food animal veterinarian should always associate non-specific hepatic clinical signs with a possibility of mycotoxicosis, and correlate agricultural practices and feed evaluation with the animal status. Good quality food and resistant strain of animals can lead to greater production and more profit for the poultry, dairy farming.

KEY WORDS: Aflatoxins, Livestock, Pathogenesis, Zoonotic importance, Prevention

INTRODUCTION

Aflatoxicosis is a disease caused by the consumption of aflatoxins. Aflatoxicosis occurs in many parts of the world and affects growing poultry especially ducklings and turkey poults, young pigs, pregnant sows, calves, and dogs. Adult cattle, sheep, and goats are relatively resistant to the acute form of the disease but are susceptible if toxic diets are fed over long periods.

CAUSES

Aflatoxins are secondary fungal metabolites produced during metabolism of carbohydrates, fats, proteins, minerals and vitamins. Aflatoxin contamination is typically found in grains and tree nuts, peanuts and peanut products, cottonseed (Fig. 1), corn (Fig. 2) and corn products, groundnut and milk. These toxins are produced by fungi like *Aspergillus flavus* and *Aspergillus parasiticus*.The most common aflatoxins are

B1, B2, G1 and G2. Aflatoxin B1 is the most potent mycotoxin. Aflatoxin B1 increases the apparent protein requirement of animal and is a potent cancer causing agent. When significant amounts of aflatoxin B1 are consumed, the metabolite M1 appears in the milk within 12 hours.

SOURCES

Contaminated grains and grain by-products are the most common sources of aflatoxins. Corn silage may also be a source of aflatoxins, because the ensiling process does not destroy the toxins already present in silage.

FAVORABLE CONDITIONS FOR AFLATOXIN BIOSYNTHESIS PRODUCTION

The formation of aflatoxins is influenced by physical, chemical and biological factors. The physical factors include temperature and moisture. The chemical factors include the composition of the air and the nature of the substrate.

Biological factors are those associated with the host species. Specific nutrients, such as minerals (especially zinc), vitamins, fatty acids, amino acids and energy source are required for aflatoxin formation. Large yield of aflatoxins are associated with high carbohydrate concentrations, such as wheat rice and to a lesser extent in oilseeds such as cottonseed, soyabean and peanuts.

The limiting temperatures for the production of aflatoxins are reported as 12 to 41°C, with optimum production occurring between 25 and 32°C. Synthesis of aflatoxins in feeds are increased at temperatures above 27°C, humidity levels greater than 62% and moisture levels in the feed above 14%.

Effects of Aflatoxins:

Immunosuppression
Carcinogenicity
Anaemia
Hepatotoxicity
Nephrotoxicity
Infertility and Abortions
Delayed onset of egg production in layers
Loss of egg production in layers
Loss of appetite, poor egg shell quality and paralysis in birds
Poor weight gain in birds (Fig. 3)
Ataxia, epistaxis, reduced milk yield, reduced feed efficiency

PATHOGENESIS

As the dosage and exposure increase, fatty retention by hepatocytes leads to multifocal lesions of lipid-laden hepatocytes, with cellhypertrophy of medium sized biliary ducts.With the loss of centrilobular hepatocytes, a new vascular plexus develops around the central vein, leading to scattered necrosis (Fig. 4) of individual hepatocytes or coalescing into multifocal infarcts. With severe chronic aflatoxicosis, hepatic lesions consist of fibrosis, necrosis, focal lipid accumulation with disseminated fatty degeneration, and atypical hepatocytes. Other lesions are nephrotoxic lesions, immunosuppression, and carcinogenicity.

Chronic, subacute aflatoxicosis may cause pyknosis and dilation of the distal convoluted tubular epithelial cells in the kidney. With an increase in dose to acute toxicity, the renal tubular epithelial cells will exhibit necrosis and may be filled with bile pigments, hyaline, and lipid.

Immunosuppression is observed in animals fed aflatoxin, but the pathogenesis is not completely understood. Aflatoxin appears to decrease the lymphocyte response to mitogens, inhibit macrophage migration, and decrease the effectiveness of humoral mediators such as complement and cause immunosuppression.

MACROSCOPIC LESIONS

Pale or slightly icteric visible mucous membrane

Pale, enlarged and firm liver (Fig. 5)

Necrotic foci in liver

Petechiae in gastro intestinal tract

MICROSCOPIC LESIONS

In early stages, the hepatic cells are loaded with fat (Fig. 6). Subsequently centrilobular necrosis sets in. The fibrous tissue proliferates and invading the parenchyma isolates the surviving hepatic cells into small groups of two or more cells or into cell cords having either single or double rows of cells. This appearance is characteristics of pericellular cirrhosis. There is marked bile duct proliferation. Fibrosis causes occlusion of the central veins and so the name Veno occlusive disease. The hepatic cells show intense fatty changes.

HEMATOLOGICAL AND BIOCHEMICAL ALTERATIONS

Aflatoxin causes hematopoietic suppression and anemia observed as decrease in total erythrocytes, packed-cell volume and hemoglobin. Total leucocyte counts are increased and differential leucocytic counts vary with concurrent lymphopenia, monocytosis and heterophilia. Aflatoxin is known to produce hemolytic anemia by decreasing the circulating mature erythrocytes. Lysis of erythrocytes will result in above the normal levels of cellular debris in circulation and consequently the spleen appear congested because of an unusually high concentration of inorganic iron and debris from the circulation.

Several biochemical parameters are affected by aflatoxin exposure. Aflatoxin decreases total serum proteins, alpha, beta and gamma globulins, with IgG being more sensitive than IgM. Total serum proteins contents are depressed due to reduced values of alpha and beta globulins and albumin, while gamma globulins are affected more variably. Serum lipoproteins, cholesterol, triglycerides, uric acid and calcium are also decreased.

DIAGNOSIS

Aflatoxin can be detected in milking cows from milk samples. However, diagnosis in non-lactating cattle is more difficult because of the variation in clinical signs, gross

pathology, and presence of secondary infection due to immunosuppression. Proper analysis of feed for aflatoxin and other mycotoxin can be a useful tool.
The usual method of detection of aflatoxins is thin-layer chromatography and also possibly cytotoxicity tests for those samples not demonstrated by conventional means.
A quick screening test for aflatoxin level in shelled corn or ground feed is the Woods' light test. A black light is held over the sample and fluorescing of a metabolite in the production of aflatoxin might be observed. This is only a screening test, subjective errors and false negatives are quite common.

TREATMENT

Aflatoxicosis is typically a herd rather than an individual animal problem.
If aflatoxin is suspected, analyze the ration immediately. Eliminate the source at once, if aflatoxins are present.
If aflatoxins are present, the source should be eliminated immediately. Levels of protein in the ration and vitamins A, D, E, K and B should be increased as the toxin binds vitamins and affects protein synthesis.
Practice good management to alleviate stress, reducing the risk of secondary infections.
Provide immediate attention and treatment for secondary infections.

PREVENTION

Raw materials of feed can be tested for detecting aflatoxins level. This will help to classify the samples for rejection or acceptance.
Check the quality of finished feeds with standards.
Mold inhibitors, blend of toxin-binders and mycotoxin neutralizing enzymes can be used in production of finished feed.
To avoid contamination of milk, lactating dairy cattle should not receive more than 20 ppb in the total ration. Calves should not receive milk from cows fed in excess of 20 ppb, because they can ingest aflatoxin from the milk. Beef cattle can tolerate slightly higher levels of aflatoxin, but yearlings and mature cows should not receive more than 400 ppb in the total ration. Weanlings should not receive more than 100 ppb in their total daily ration.
Aflatoxin levels which are considered safe in animal feedstuffs are 20 ppb or lower. Feed contaminated with aflatoxin at a level greater than 20 ppb is not to be sold. Many attempts have been made to detoxify feed but none proven to be totally feasible. Some methods include physical separation, milling, heat, biological inactivation with microorganisms, and chemical treatments.
Ammoniation reduces aflatoxin contamination in grain but is not currently approved by the FDA for use in food animals because of uncertainity about byproducts produced. Numerous anticaking agents are available to sequester or bind aflatoxins and reduce absorption from the gastro intestinal tract. One effective binder for aflatoxins is hydrated sodium calcium aluminosilicates, which reduces the effect of aflatoxin when fed to animals at 10 lb/ton. They also provide substantial protection against dietary aflatoxin. This reduces aflatoxin M1 in milk by approximately 50% but do not eliminate

residues of aflatoxin M1 in milk from dairy cows fed aflatoxin B1. Other absorbents such as sodium bentonites, polymeric glucomannans have shown variable but partial efficacy in reducing low-level aflatoxin residues in poultry and dairy cattle. To date, the FDA has not licensed any product for use as a mycotoxin binder in animal feeds.

CONTROL

If any mortality, after complete collection of history of particular case, post mortem examination can be carried out to evaluate the cause of the death and also to control the spreading of disease to other animals or birds.
Analyze the feed formulation for aflatoxin content.
If aflatoxin level is high in finished feed, withdraw and discard those feeds.
Educate the farmers on the need to ensure proper drying of products to prevent aflatoxin contamination.

ZOONOTIC POTENCY TO HUMAN

Human health hazards by aflatoxin were mainly due to people eating aflatoxin contaminated food and milk.
Direct ingestion of aflatoxins (mainly B1) in contaminated foods of plant origin such as maize nuts and their products had an influence on humans and livestock. Ingestion of aflatoxins carried over from feed into milk and milk products including cheese and powdered milk, where they appear mainly as aflatoxin M1.
In addition to the carryover into milk, residues of aflatoxins may be present in the tissues of animals that consume contaminated feed. Aflatoxin residues have been found in animal tissues, eggs and poultry following the experimental ingestion of aflatoxin-contaminated feed.
Contamination of milk, egg and meat can result from animal consumption of mycotoxin contaminated feed. Aflatoxins, ochratoxin and some trichothecences have been given considerable attention, because they are either carcinogenic or economic concern in animal health.
The expression of aflatoxin related diseases in humans may be influenced by factors such as age, sex, nutritional status, and concurrent exposure to other causative agents such as viral hepatitis or parasite infestation.

CONCLUSION

The effect of mycotoxins on food producing animals has only recently been realized. Economic impact has only been speculated, but may be significant. The clinical signs are often non-specific, and chronicity is often the rule.

The practicing food animal veterinarian should always associate non-specific hepatic clinical signs with a possibility of mycotoxicosis, and correlate agricultural practices and feed evaluation with the animal status. Good quality food and resistant strain of animals can lead to greater production and more profit for the poultry, dairy farming.

Fig. 1 Contaminated cotton seeds

Fig. 2 Contaminated corn

Fig. 3 Poor weight gain in chicken

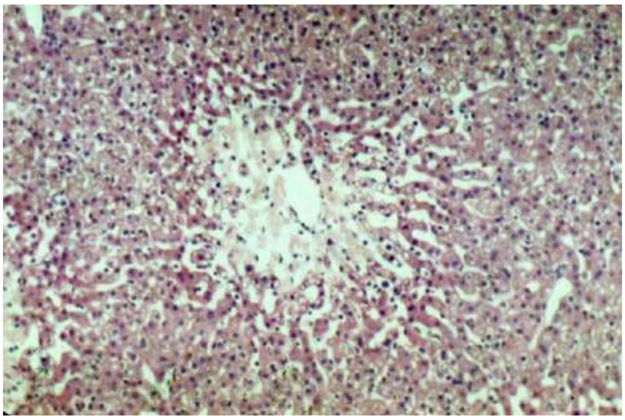

Fig. 4 Centrilobular necrosis in liver

Fig.5 Pale and enlarged liver (right)

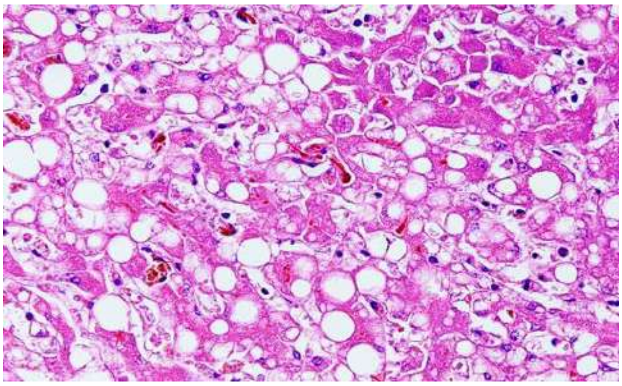

Fig. 6 Fatty degeneration in liver

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Mycorrhizae: Engineers for a sustainable future

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Abstract
Over the past few decades, the growing body of research on mycorrhizal fungi has been exploring their roles in maintaining and enhancing a wide range of ecosystem functions. These functions include, and are not limited to, maintenance of soil health, plant nutrition, removing hazardous contaminants from soil, prevention of soil erosion and suppressing pathogens in soil. As a result, mycorrhizae offer great potential as ecosystem engineers, capable of meeting various objectives of sustainable agriculture, forestry, ecological restoration and biodiversity conservation. This article attempts to offer an insight into the fascinating world of such a mutualistic interaction, some of the benefits it offers to our planet and why it is imperative to integrate mycorrhizae into discussions for a more sustainable future.

INTRODUCTION

We often do not realise the ways in which mycorrhizal associations have shaped our ecosystems. It is believed that when the earliest plants started their transition from an aquatic environment to the land surface around 500 million years ago, those plants (with a very rudimentary root system) were surely not equipped to extract nutrients for its growth from the mineral soils around. Perhaps it was a symbiotic relationship that developed between plant roots and soil fungi that enabled the plants to derive those nutrients from soil and thus enable their colonisation of land, that eventually led to the evolution of terrestrial plants (Field et al., 2015). It is this relationship that we term as 'mycorrhiza' (taken from the Greek "*mykes*" meaning fungus and "*rhiza*" meaning root).
Almost 90% of the terrestrial plant families exhibit associations with mycorrhizal fungi. The fungal partner in this association is an obligate symbiont, which depends on the plant for fixed carbon for its nutrition. The benefits received by the plant include improved water relations and resistance to pests and diseases. However, the most important of all benefits for the plant is the increase in uptake of nutrients likephosphorus and zinc from soil, which are essential nutrients for plants but immobile in soil. Therefore, mycorrhiza is a prominent example of mutualism.

[Before we proceed further, it would be helpful to keep in mind the difference between 'symbiosis' and 'mutualism'. In common usage, these two terms have often been used interchangeably. However, for this article, let us follow the more robust scientific definition of the terms. Symbiosis refers to a close and prolonged association between two organisms of different species (Lewis, 1985). Mutualism means mutually beneficial interactions between members of the same or different species. From this, we can infer that mutualism falls under the broader term of symbiosis. Symbiosis also includes parasitism, commensalism and amensalism. The interactions between plant roots and associated fungi does cover all these categories. However, only when this relation is mutualistic, we term is as 'mycorrhizal']

Depending upon the kind of partners and the structure of the bonding between them, mycorrhizae have been divided into few categories like arbuscular, ecto-, ectendo-, arbutoid, monotropoid, ericoid and orchidaceous mycorrhizae. The most common of all these types is arbuscular mycorrhizae, also known as 'vesicular arbuscular mycorrhizae' or VAM. In VAM, the fungi produce very finely branched hyphae called 'arbuscules' and lipid-rich globose structures called 'vesicles', both in the root cortex. VAM fungi gets more attention than the other kinds of mycorrhizae in the literature concerning soil ecology because of its widespread abundance and ubiquity compared to the other kinds. Mycorrhizal research in cultivated crops almost exclusively refer to VAM fungal associations as a result (Jeffries and Rhodes, 2008)

Over the past couple of decades, the growing body of research has been digging into the roles of mycorrhizae in influencing the structure and functions of plant communities. As mycorrhizae have a suite of such functions that can maintain or shift ecosystem dynamics, they have been dubbed as ecosystem engineers. For example: it has been seen that mycorrhizal associations in a crop plant can suppress the growth of many weed species which are non-mycorrhizal. This opens an avenue for effective weed control without utilising copious amounts of herbicides (Cameron, 2010). It would be interesting to explore some of the roles that mycorrhizae carry out in the ecosystems that warrant deeper research on them.

Role of mycorrhizae in nutrient exchange:

The most obvious basis behind mycorrhizal associations is the need for exchange of nutrients between the fungus (which is the obligate symbiont) and the plant as mentioned earlier. The exchange of nutrients takes place in a space defined by the boundaries of the root cortex and fungal arbuscules. What the mycorrhizae does particularly well is that it extends the fungal hyphae beyond the host root system, thus allowing a bigger volume of soil to be available for uptake of nutrients like phosphorus, zinc and to some extent nitrogen.

Role of mycorrhizae in control of plant diseases:

Fungal colonization of the roots greatly reduces the severity of diseases caused by plant pathogens. There are a lot of changes in the physiological, histopathological and biochemical characteristics of a plant when the mutualism develops in the roots. Apart from that, changes occur in the rhizosphere microbiome that greatly influence the activity of antagonistic microbes. The cumulative effect of all such changes leads to effective bio-protection of plants from pathogens. As a result, mycorrhizae are being considered as eco-friendly alternatives for chemical pesticides, to foster sustainable agriculture and forestry.

Role of mycorrhizae against heavy metal toxicity:

There is an increasing recognition of mycorrhizal associations being effective bio-remediators of soils suffering from heavy metal toxicity. Metal-hyperaccumulating plants have been observed to harness mycorrhizae, under high levels of cadmium, lead and mercury in soils, to take these up into the plant body though they are non-essential elements. The development of zones of extreme heavy metal toxicity in soils is rampant under expansion of mining, quarrying, industrial activities and agriculture. Hence there is a gradual build-up of metals like copper, iron and zinc in such areas which severely hamper the activities of soil microbes. Mycorrhizal fungi can store high levels of such metals in its structures for plant nutrition.

Role of mycorrhizae in agricultural productivity:

Highly intensive agricultural practices put huge pressures on the environment. Conventional farming practices, driven by the goal to achieve high crop productivity, lead to increase in monocropping and accumulation of surplus amounts of fertilisers in soil, which are not taken up by plants. This leads to increased cost of production,reduction of biodiversity, surface runoffs, groundwater contamination and eutrophication of water bodies which aggravate further and disrupt the ecosystem stability and functioning.

However, discussions about natural resource management strategies and sustainable agriculture have been gaining momentum. Agriculturists all over have been involving themselves in methods to conserve ecosystem services without compromising crop yields, invoking the ideas of healthy soils (Kibblewhite et al., 2008). Soils with higher diversity of soil microbes and their functions are healthier and more resistant to perturbations like biotic and abiotic stresses. Mycorrhizal associations enable crops to uptake nutrients more efficiently from soil. However, excessive use of chemical fertilisers leads to a reduction of mycorrhizal activity in soils. Mycorrhizae showcase their full potential in areas of low and intermediate concentrations of nutrients (particularly phosphorus). Therefore, cultivation strategies which focus on mycorrhizae will result in reduced usage of fertilisers.This aligns strongly with the objectives of sustainable agriculture, horticulture as well as forestry, where the impetus is on harnessing natural processes (like soil biological processes) to sustainably gain maximum productivity without adversely affecting the environment.

Role of mycorrhizae in soil structural aggregation:

The hyphae of mycorrhizal fungi producea glycoprotein called glomalin, which protects the delicate hyphae from water and nutrient loss. What it also does is forming stable soil aggregates which provides the environment for the symbiosis to occur with minimum external perturbations. Therefore, agricultural practices which hamper the symbiosis are those which frequently disrupt the soil aggregates and hyphal networks: excessive ploughing and tilling, for example. Practices like no-tillage, reduced tillage, cover cropping and reduced usage of synthetic fertilisers enhance the mycorrhizal activity and help maintain soil fertility sustainably.

Role of mycorrhizae in ecological restoration:

Mycorrhizal associations help plant to cope in conditions of stress like drought and reduced soil fertility. Therefore, it is receiving considerable amount of attention in discourses on ecological restoration and revegetation of degraded landscapes. Landscapes inching towards desertification show reduced soil biological activity and health. In order to revegetate such lands, we need to establish communities of shrubs or small woody plants, which by itself is difficult under low-fertility soils. However, mycorrhizal associations provide a channel for the plant to efficiently scavenge soil nutrients in degraded conditions.

Role of mycorrhizae in forests:

Most of the trees in forests have ectomycorrhizal symbionts which help in the mobilisation of nutrients from soil for the host plant. What is more fascinating is, in undisturbed forests, ectomycorrhizal associations can connect roots of several plants into one intact network. These connections are very intricate and function like a bustling and persistent market economy below ground. The benefits of such associations are not limited to nutrient exchange. The network also facilitates signalling and communication between plants in response to stimuli like drought or herbivory, which allows plants to respond to such threats accordingly. For these reasons, it is understandable why the mycorrhizal networks have been termed as 'wood-wide webs' (Simard et al., 1997).

CONCLUSIONS: WHAT LIES AHEAD?

Slowly but steadily, application of mycorrhizal propagules as bio-fertilizers and bio-protectants is becoming established as a suitable agronomic practice to foster sustained crop productivity and soil health. The effectivity of inoculation practices, however, depend upon native mycorrhizal diversity and functionality in the ecosystem. It is possible that mycorrhizal inoculations turn out to be ineffective, or, for worse, negatively affecting plant productivity. Therefore, understanding the functions of such symbioses in an ecosystem is extremely important before we integrate them into sustainable agricultural management strategies. Studies on mycorrhizae on natural ecosystems can yield a lot of insights into fundamental questions in ecology and evolution. It is quite likely that restoration strategies will receive a boost from considering mycorrhizae as agents of bioremediation.

Mycorrhizae play an influential role in the formation and maintenance of our ecosystems as we know them. In a world fraught with challenges like climate change and depletion of natural resources, mycorrhizae offer a gateway to implement many ideas for biodiversity conservation and management. The time is ripe for the scientific community to understand more about how these intricate mutualisms work and how to make interventions in such processes to reap maximum ecological benefits without compromising productivity.

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Birds: Non-insect pest of storage food grains

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ABSTRACT

Birds causes the damage in the crops at different stages *viz.* sowing, ripening and also harvesting stage of the crops. It also causes damage at post harvest stages like grain storage, shelling yards and marketing places. They are also responsible for spoilage, contamination with excreta, feathers and also with dead bodies. After harvesting, the crop yield is kept and stores in various forms of storage structures wherein they also cause damage after entering through broken vents, doors and windows because of poor management of the storage godowns.Various birds management strategies have adopted including building exterior , birds scaring, food processing and storage facilities designs.

INTRODUCTION

Birds are known to cause considerable economic damage to variety of crops during vulnerable stages in different agro-ecological regions of the country. The extent of bird damage to any crop depends on several factors like concentration of local bird population, total area under the crop, cropping pattern habitat of the area, season and physiological status of the birds, stated the report. There are 18,000 birds species in the world among them 1301 species are found in Indian sub-continent. It identified 63 bird species of birds, 1,364, from 19 families that caused damage to several crops. A whopping 52 bird species attacked cereals, pulses got attacked by 14 bird species, while oilseeds faced damage risk by 15 species, and fruits by 23 species. They also caused damage to the crops of smaller grains such as pearl millet and sorghum as well as maize.

As per the Panse Committee report about 0.85 per cent losses are caused due to birds in storage. Generally, it has observed in India that these store houses have broken windows and ventilators that give passage to pest birds leading to make nests inside the building.

The nature of damage of some important birds which are associated with grain losses are as follows:

1. **Sparrow (*Passer domesticus* L.)** Sparrow is one of the most important pest causes damage in storage conditions. It is omnivorous, principally granivorous, lives or enter in houses and mainly in warehouses. Contents are damaged in bag storage.


Sparrow

In open storage, maximum losses have noticed. Since they gather in large numbers, most sparrow damage is related to their nesting and feeding habits. In these situations, they are making considerable nuisance and often cause unsanitary or odoured conditions.

2. **Pigeon (*Columbia livia* G.)** This bird is mainly granivorous and eat the food grains in Marketing places like mandies, godowns etc. They scavenge on grains and seeds and consequently can be very numerous around grain elevators.

Pigeon

They contaminate the food grains with their excreta, feathers and also transmit some diseases and also responsible for food poisoning. Generally, it stay in large flocks. They made nests in man made structures such as buildings, bridges etc. These can be seen on railway platform wall, electric wires, shops, houses and threshing yards, rice and flour mills etc. During the ripening of fields of wheat , bajra, sorghum and maize, they visits and causes the damage of the grains.

3. **Crow (*Corvus splendens* V.)** They are Omnivorous and is considered as the best scavenger. It feeds on grain mixed up in refuge sweeping, spillage around warehouses.

Crow

It enters warehouses only unattended the grains for long time. They cause maximum damage in the threshing yards and also in the open storage.

4. **Parrot (*Psitticula Krameri*)** It is important bird pest of various ripening cereals crops, open storage etc.

Parrot

In sunflower, Safflower, maize, bajra and various fruit crops, it causes considerable losses. They usually fly in large flocks. The damage is more than what they actually consume.

5. **Mynah (*Acridotheres tristis* L.)** These birds in groups invade standing rops of sorghum, bajra and some vegetables, fruit orchards and causes the damage.

Mynah

It generally damages food grains in marketing places like mandies but seldom enters warehouses. It is Omnivorous and good scavenger, feeds on kitchen waste and grain in refuge.

MANAGEMENT OF PEST SPECIES OF BIRDS

In different situations, alternative methods of reducing bird damage are more successful, compared to many avicides. Prevention is the best and safe remedy for bird management. This includes exclusion, sanitation, altering the nesting sites and the use of noise for frightening.

FOOD PROCESSING AND STORAGE FACILITY DESIGN:

Exclusion is the basis for many aspects in sanitary facilities as well as modification or repair of existing older facilities (Michael and Pederson, 2000). Exclusion principle begins with the planning and selection of the facility site. Imholte and Imholte-Tauscher (1999) stated that selection of a plant location requires that economic consideration be balanced with product safety. A buffer zone or area surrounding the actual facility is desirable that can be planned for new facilities but may not be present around existing storing houses.

Properly maintained space surrounding a food plant / warehouses greatly reduce the potential for environment conditions that favour pest pressure from rodents, birds and insects. Maintaining the area surrounding a food processing plant / warehouse free of all weeds, grasses, heap of debris or other conditions that favour the attraction and development of rodents, birds and insect population is an effective way of "excluding" these pests from entering the storing facilities. Lights should not be used near the entry ways of loading / unloading docks of food processing facilities / warehouses. Sanitation around the grain facilities is very important even though in some instances it can be very time consuming.

BUILDING EXTERIOR:

Ware houses and food plants should be made in such a way that excludes pests. On the exterior wall, solid concrete construction is preferred over concrete block. Well planned openings to grain facilities provide challenges for pest exclusion. All doors, windows, loading docks, intake and exhaust vents are some of the openings to safeguard against pest entry. Windows if needed that should be properly screened. Heavy mesh screen will exclude rodents and birds that may seek entry or nesting sites in the vents. All personal entries and exit doors should fit tightly so that leaving no more than 1/3-1/4 inch spaces at the top, bottom and sides of the door. The birds and insect entry during loading operations can be minimized by use of air curtains that allow fork truck passage. Air curtains can be effective in excluding dust and flying insects.

Too often the roof area of a grain facility is overlooked as a source of pest entry into the plant. Birds may be attracted to grain spillage. Suitable protective arrangements should be made to get rid of them.

BIRDS SCARING:

Now-a-days, noise can effectively be used to frighten birds and insects like locust also. If automatic devices or personnel create enough noise at the time when normally birds arrive they change their foraging and flight routes and no longer comes to that sites. Falcony response is used to deter population of nuisance birds whose entry cannot be restricted through proofing measures such as netting.

Falconry response of bird management method makes the area undesirable to the birds and encourages them to establish a new pattern of behavior in another area. Unlike audio or mechanical devices, birds never habituate to the presence of a live predator. These systems are natural and effective in scaring birds without the need to catch the prey._Use of audio system which include to broadcast recording of distress calls may be effective for initial stages but the birds soon understand the system and will not take care of it.

By putting dummys roughly similar to man in area at different places may also be used. Alternatively dead / stuffed crows or sparrow are hung from tree tops preferably with spread out wings or in godowns roof for scaring away birds. When manual labour is available shooting of dry mud balls and hanging reflectors etc. may be of some use but in the long run prove costlier. Birds scares are also used.

A mixture of oxygen and acetylene gas is utilized to create loud noise at irregular intervals. This should be preferably be kept at a height e.g. hung at the ceiling of godowns or on tree top for getting better results. When their use is combined with throw balls, results are more effective. To summarise, purpose of avoiding bird damage is to keep them away from the storage of food grains areas.

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Lodging in wheat: its causes, ill effects and management for higher productivity and profitability

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ABSTRACT

Lodging in wheat is permanent displacement of stems from their perpendicular position through creation of an angle from the vertical as a result of wind induced buckling or breakage in stems or roots or both. Lodging causes a drastic reduction in grain yield and quality which ultimately leads to lower profitability. Wheat lodging can occur at any time from booting stage to harvesting stage (*i.e.*, a period of 60 days). After lodging, stems of wheat plants create different angles with its base and sometimes stems lie down horizontally on the ground. Tall cultivars, early sowing, excess use of fertilizers and irrigation water for extracting higher yield are some of the main reasons of wheat lodging. Use of lodging resistant cultivars, optimum use of fertilizers and irrigation water, timely sowing and foliar application of plant growth regulators at certain doses are some important agronomic practices for lodging management.

Keywords: Lodging, plant growth regulators, wheat

INTRODUCTION

Cereals are the staple food of world's population. Cereals are the crop plants which are grown for their edible starchy seed botanically known as caryopsis. Wheat (*Triticum aestivum* L.) is one of the leading cereals. The cultivated area of wheat is largest among all the crops in the world. India's share in global wheat production was 15.36% in the year 2017-18 (USDA, 2018). In India, wheat is the second most important staple foodgrain after paddy. India took the 2nd top position after China in wheat production during 2017-18 (Ramadas *et al.*, 2019) and wheat consumption is oscillating around 50-60 kg per capita per year (Mottaleb *et al.*, 2018). Indo-gangetic plains region (IGPR) extends from the arid and semi-arid zones in Rajasthan and Punjab to the humid and per-humid deltaic plains in West Bengal over a length of about 1600 km and a width of 320 km. Rice-wheat system is the major cropping system in the IGPR covering an area of around 10.5 mha. Lodging is a serious threat to wheat production. In cereal crops, lodging tends to be more near harvestable maturity. Lodging can reduce grain yield of wheat upto 80% (Piñera-Chavez *et al.*, 2016). In India, the range of yield loss in wheat is 12-66% due to crop lodging (Rajkumara, 2008).

CAUSES OF LODGING IN WHEAT

Early sowing of wheat enforces the crop to mature early by temperature rising of the environment during the growing period. This results in high vegetative growth of plants and ultimately breakage at the internodes due to wind gusts. Nitrogen fertility increasing beyond a certain limit enhance the vegetative growth the crop vigorously and resulted in bending of the stems and ultimately decreased the yield attributes and grain yield. Tall varieties of wheat (≥120 cm) are highly susceptible to lodging. Due to wind pressure or high soil moisture condition, tall plants lodged easily. Heavy irrigation or adverse weather condition (e.g. rainfall, strong winds and hail) at dough stage of wheat also causes lodging. Intensive tillage operation for land preparation and weed management pulverize the soil, breaks the soil structure and creates hard pan below the surface. Root growth of wheat plants is affected due to this hard pan and root anchorage of the plants also reduces due to loose soil. This increases root lodging tendency of wheat plants.

MECHANISMS OF WHEAT LODGING

The nature and extent of lodging are closely related to culm characteristics. There are two types of failure mechanism, (i) stem lodging: it occurred when the bending moment of a shoot (shoot leverage) exceeds the failure moment of the stem base (stem strength) and (ii) root lodging: it occurred when the bending moment of a plant (plant leverage) exceeds its anchorage failure moment (anchorage strength). In stem lodging, roots are held firmly in a strong soil where the wind force buckles one of the lower internodes of the shoot. Root lodging is associated with rainfall that weakens plant anchorage combined with wind induced force acting on the upper portion of the plant. Shoot leverage is wind induced force acting on the base of the shoot. Stem failure moment is stem strength at the point of failure. Plant leverage is wind induced force acting on the plant. Anchorage failure moment is anchorage strength at the point of failure. When lodging happened from the buckling of stem just below the spike, it is known as necking.

ANGLE OF LODGING

No lodging occurs when angle of lodging is 0° from the vertical. Smaller yield losses have been observed when the angle of lodging is ≤30° from the vertical. Lodging at 45° angle shows one quarter to one half of the grain yield loss incurred from 80° lodging in wheat.

DELETERIOUS EFFECT OF LODGING IN WHEAT

In wheat, lodging increase pest and disease susceptibility and induce negative impact on crop development (*i.e.*, reducing number of grains m^{-2}, test weight). This ultimately decreases grain yield of wheat. Lodging may limit yield improvement by 2 ways: a) directly by reducing photosynthetic capacity due to changes in canopy architecture (Berry and Spink, 2012) and b) indirectly by improper partitioning of dry matter into the support structures. Lodging increases the chance of grain sprouting in spike due to the moist environment and this reduces Hagberg falling number (HFN). Bread-making quality is measured as HFN. A HFN of at least 250 s is required to produce good quality bread. Lodging induced during early grain filling stage reduced grain quality by reducing the HFN from 289 s to 114 s, 1000-grain weight from 42.2 g to 37.2 g and specific grain weight from 70.3 kg Hl^{-1} to 65.8 kg Hl^{-1} (Weibel and Pendleton, 1964). Lodging after early grain filling caused smaller effect on the quality of wheat grains.

CRITICAL GROWTH STAGES FOR LODGING

The effect of lodging on yield losses depends on the growth stages of wheat. A crop that lodges early (*i.e.*, at tillering and jointing) recovers through the development of 'elbow joints' at the lower stem nodes. The cells on the lower side of the node elongate and force the stem to erect. At the end of vegetative phase (*i.e.*, initiation of booting stage), the stem cells mature and are no longer capable of elongation to enable plant recovery. The highest lodging-induced reduction in grain yield occurs when wheat is lodged flat (90° angle from vertical) at flowering or early grain filling. Yield reduction of wheat from this type of lodging is upto 80%. Fischer and Stapper (1987) reported that grain yield of wheat was decreased in the range of 7-35% when lodging occurred within the first 20 days after flowering. The lodging score at harvest (Stapper and Fischer, 1990) may be wholly due to a single, late lodging event immediately before harvest and not reflect on the development of lodging through the season. Lodging occurred at the end of the crop cycle imposed lower effect on grain yield than lodging at other growth stages but the grain yield significantly reduced in case of lodging-prone wheat cultivars (Tripathi *et al.*, 2004).

MEASUREMENT OF LODGING

There are several indicators to measure lodging. Among the indicators, lodging score and lodging index are used frequently. Lodging score was calculated by the following formula of Fischer and Stapper (1987).

$$\text{Lodging score} = \frac{(\%\ \text{plot area lodged} \times \text{angle of lodging from the vertical})}{90}$$

where, % plot area lodged = (lodged area/net plot area) × 100; 0° angle of lodging from vertical = Main stem standing upright; 90° angle of lodging from vertical = Main stem laid down horizontal

The formula of lodging index was developed by Wiersma *et al.* (1986). After that it has been modified as follows.

$$\text{Lodging index} = \frac{\%\ \text{plot area lodged} \times \text{degree of lodging}}{100}$$

where, % plot area lodged = (lodged area/net plot area) × 100; degree of lodging 0 = Main stem standing upright; degree of lodging 100 = Main stem laid down horizontal

The loss of potential yield due to lodging can be calculated by the equation developed by Stapper and Fischer (1990). They showed that approximately 0.5% of potential yield is lost for each % area of wheat lodged averaged over each day of the grain filling period.

$$\text{Yield loss of wheat} = 0.000125\alpha \sum_{T=10}^{50} \%\ \text{plot area lodged}$$

where, the grain filling period (T) lasts from days 10 to 50 (generally 10 days in India) of the 60 days lodging risk period and the potential grain yield of wheat α is taken as 8 t ha^{-1}.

Table: Lodging score during different growth stages of timely sown, irrigated wheat at instructional farm, U.B.K.V., West Bengal (pooled over 2016-17 and 2017-18)

Treatments	*Lodging score at flowering	*Lodging score at dough
Fertilizer (F) application		
No fertilizer	0.00	0.00
RDF	0.77	1.10
150% RDF	2.25	3.54
150% RDF + 15 t ha^{-1} FYM	3.69	5.81
S.Em (±)	0.343	0.495
CD (P=0.05)	2.28	2.89
Growth regulator (GR) spraying		
Water spray	3.21	4.77
Chlormequat chloride @0.2% (CCC)	1.15	1.77
Tebuconazole @0.1%	1.90	2.44
CCC @0.2% + Tebuconazole @0.1%	0.46	1.48
S.Em (±)	0.208	0.344
CD (P=0.05)	1.42	2.04

RDF: Recommended dose of fertilizer; FYM: Farmyard manure; *Angle of lodging was 45°

MANAGEMENT OF WHEAT LODGING

Delayed sowing of wheat encourages the crop to produce less straw yield. Wheat plant does not get enough time to complete its growth stages properly and the problem of dwarfing is seen. This reduces lodging in wheat. Optimum rate of nitrogen (N), phosphorus (P) and potassium (K) application instead of higher rate of N alone enhance lodging resistance through better partitioning of photosynthate in all the support structures. Foliar application plant growth regulators (PGRs) such as chlormequat chloride (CCC), ethephon, trinexapac-ethyl and tebuconazole etc. at certain rates twice during 1st node and flag leaf stage controls wheat lodging. PGRs reduce the shoot length of wheat plants which is mainly achieved by reducing cell elongation, but also by decreasing the rate of cell division. PGRs control wheat lodging by 2 ways: (i) inhibition of gibberellic acid (GA) biosynthesis which reduces plant height and subsequently reduces lodging and (ii) release of ethylene which improves root growth, formation and elongation of root hairs to control root lodging. Application of the recommended rate of N in 3 or 4 splits instead of single application as basal increases lodging resistance. Semi-dwarf wheat varieties having stiffer straw, thicker internodes and smaller above-ground biomass than tall wheat varieties should be used for obtaining higher grain yield due to reduction in lodging. To avoid lodging, many farmers in South Asia forego the last irrigation (Hobbs *et al.*, 1998). This may be crucial for grain filling. A light irrigation can be given at dough stage of wheat, if required. Conservation agricultural practices such as zero tillage and maintaining crop residues in field improve soil structure and root anchorage of the wheat plants, which ultimately reduces the risk of lodging.

CONCLUSION

From the above study, it can be concluded that lodging is a serious threat in wheat cultivation. To overcome this problem, some agronomic management practices should be followed. Among these practices, spraying of PGRs at certain rates twice during 1st node and flag leaf stage of wheat is gaining popularity in India. Grain yield and quality of wheat is enhanced due to adoption of the above mentioned lodging management practices which ultimately increases the net return and benefit-cost ratio.

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Mango cultivation in Hills - A success story in Tamil Nadu

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Mango (*Mangifera indica)* is one of the important fruit of Indian native. The tree grows from seeds and can grow up to 10-40 m height. Mango trees are evergreen in nature with rounded canopy cover. The roots are long and un-branched and measure up to 8 m length. The leaves have a set of interesting features, the color of young leaves varies between varieties. They are generally tan-red, yellowish-brown, or pink in color when young. They have a series of different shades as they grow and finally became dark green at maturity. The fruits are fleshy, fibrous, and of different shapes.

Mango is a subtropical fruit and grows at 600 m above sea level. The climate and soil are the two important factors that play major role in mango cultivation. Though, mangoes can grow in a wide variety of climates, it performance best in tropical and subtropical climatic conditions. They need a good amount of rain during their growth period and a dry spell during the flowering period. In other words, it needs a good amount of rainfall from June to October and a dry spell from November. The rainfall, high humidity, or frost during the flowering period may hinder the flower formation process.

Mango plants are grow well in all types of soils. However, the trees grown in well-drained and deep soils will yield better. Red, loamy soil is the most ideal for mango cultivation in India, mango plantations are seen in alluvial, clayey, or laterite soil. The soil with rich organic content is ideal for mango plantation.

Hill cultivation

For utilization of wasteland and conservation of natural resources like soil and water from erosion, various trees are planted by the forest department in hill regions of Tamil Nadu. Especially in Salem, Dharmapuri, Krishnagiri and Theni districts which are having lands mixed with hills and hillock. The farmers in the hill area are utilizing the hill's land resources for mango cultivation and income generation (Fig.1).

Hill soils

The soils of these hill regions are shallow to moderately deep, mixed with gravels and stones. Steep slopes which causes excess runoff and leaches the soil nutrients may leads to poor yields in hilly region than the plains. Even though, Soils with a good amount of iron peroxide and 5-10% lime can produce good quality mango fruits. Fruits produced from such soils have a bright red tinge (Fig. 2). A Hill soil, with pH between 4.5 and 7.0 is preferred for mango cultivation. In order to overcome the acidity and improve soil organic matter content in the soil, peat moss is mixed for mango tree plantation.

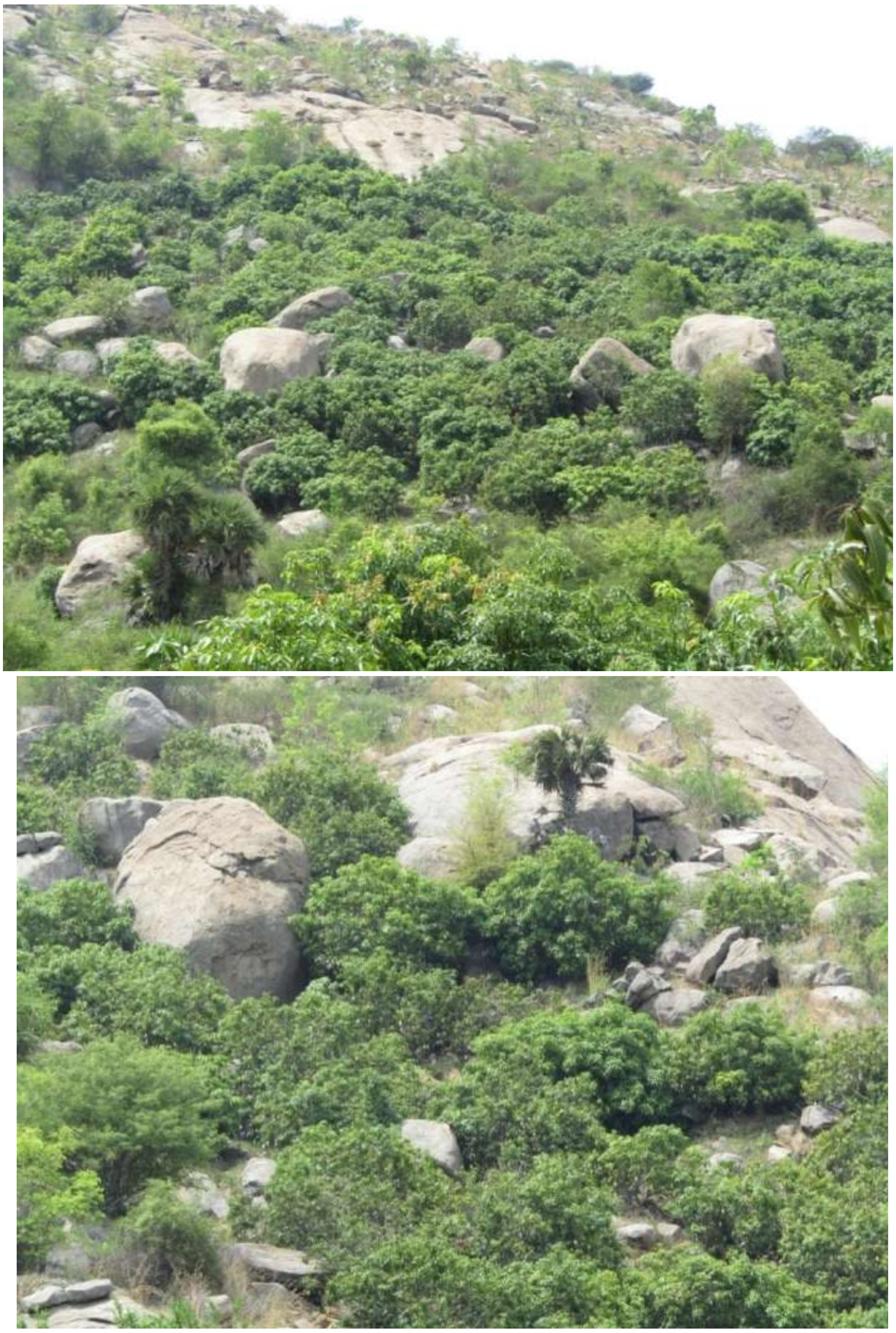

Fig. 1 Mango cultivation in hills

VARIETIES SUITABLE FOR HILL REGION

Mango varieties like Bangalora (Totapuri) and Neelam were preferred by the farmers of hill region. Bangalora (Totapuri) is a commercial variety grown in Southern India which is golden yellow, and oblong shaped, medium to large in size, with a necked base. Keeping quality of this variety is very good and widely used for processing purposes. Neelum is another commercial and late season variety owing to its high keeping quality it is ideal for transporting to distant places. The fruit is medium in size, ovate oblique in shape and saffron yellow. Both varieties are predominantly cultivated by the farmers in the hills of Tamil Nadu. Though the soil quality is poor farmers tend to cultivate mango in the hill regions due to very less management cost and not much management practices involved.

Fig. 2 Profused mango yielding in hills

YIELD AND INCOME

Generally, the cost of production of any commodity plays a vital role to determine the level of returns and the life of products. Normally mango trees do not begin bearing in an earlier stage of life they starts bearing after three years. Though hill regions are not highly preferable for mango cultivation, for sustainable utilization of hill land resources and income generation mango can be cultivated in these regions. As per the field observation farmers are happy about plant performances and yield and net returns in the hill environment.

The success story information collected from progressive farmer Mr. G. Seralanathan in Karadihalli village, Kaveripattinam block, Krishnagiri district, Tamil Nadu.

Yaks: The treasure and ship of mountains

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ABSTRACT

Yak is a remarkable bovine species of socio-economic importance in high hill and snow bound areas in India, Bhutan, China, Mongolia, Nepal and other parts of central Asia. It is a multipurpose animal, reared on pastoral system on alpine pastures. Yaks provide milk, meat, fibre, hide and dung at locations where other agricultural activities, including livestock husbandry, are not available. The yak is used as a pack animal for the transportation of household goods and is the backbone of the livelihood support of the tribal population of yak rearers in India. At present, yak husbandry is being confronted with so many issues like indiscriminate breeding, degradation of highland pasture, prevalence of diseases, unscientific management practices and global warming. The climate change has special impact on emergence and new transmission modalities of trans-boundary diseases, vector borne diseases and macro parasites of yaks. Therefore, great challenge is left in future with the institute to make the yak husbandry system more remunerative by improving germplasm, addressing feed crisis especially during winter, adopting scientific management practices, value addition and improving quality of yak products, networking of stakeholders to address problems on a platform and finally more income to yak rearers.

Keywords: yak, husbandry, management, problems

INTRODUCTION

Yak rearing is an eco-friendly and economically important traditional technology in high altitude hilly Himalayan ecosystem. It continues to represent the lifeline of highlanders. It fulfills a much wide range of functions and provides a large number of products. Yak thrives under harsh environment and its maintenance is ecologically important.

Moreover, due to its importance on livelihood and socio-economic issues of yaks, this species has earned several names like the Bison of Tibet, Ship of the Plateau, Coconut of Animals or simply Gold of Tibetans.

Yak (*Poephagus grunniens*) farming is an eco-friendly economically important traditional technology practiced based on traditional knowledge by tribal's living in high altitude hilly ecosystem. It is part and parcel of social and cultural fabric of tribal yak herdsmen living in difficult hilly terrains of Himalayas in India. The Yak belongs to the order Artiodactyla, family Bovidae, sub family Bovinae, genus Bos and subgenus Poephagus. China is the original home-tract of yak having long history yak rearing. *Bos grunniens* means the grunting ox. The yaks are reared under free-range system and are found in alpine and sub-alpine regions usually between 3000-4500m above mean sea level (msl) with a cold, semi-humid climate and even at 6000m above msl. The home tract of yaks is characterized by a harsh climate of cool moist summer, severely cold winter having availability of grazing resources restricted by very short growing seasons. The yak germplasm has lots of unexploited potentials viz. cold tolerance, conversion of coarse roughages, sustenance on limited fodder, good markets for milk/meat products, packability on high and difficult hilly terrain and finally intimacy with the socio-cultural milieu and livelihood of the tribal yak rearers of the region.

Yak plays a multifarious useful role and indispensable to the highlanders under the prevailing cultural and socio-economic conditions. The range of products and services provided by the yak includes; milk, meat, wool and leather for clothing, blankets, bags implements, rugs, and tents; bones for carving; as means of transport for trade and agricultural production and nutrient recycling. They also serve as important asset for socio-economic (financial security) and cultural functions (status, dowry and religious festivals) besides serving as tourist attraction for trekking. They maintain commercial linkage between the nomads in high altitude and sedentary people at lower altitude. Yak plays an important role in the maintenance of agro-biodiversity in most fragile ecosystem through seed dispersion and manuring. Different byproducts from yak milk and meat are used for human own consumption as well as for religious offerings, and for procuring other essential items from the lower altitude habitat through barter system. There is huge demand for white tail as white tail is preferred for making holy chawar which is used in temples, gurudwaras (place of worship for Sikhs), and by business community for religious purpose. The yak products like milk and meat are the main source of protein requirement of the isolated highlanders who have little access to modern life. The milk yield in yaks ranged from 129-282 kg in a lactation length ranging from 120 days to 300 days, meat yield ranged between 70-190 kg, coarse hair yield ranged from 3.0 to 6 kg per year, fine hair ranged between 0.3-0.6 kg. The performance of hybrids of yak and cattle are superior, which are preferred by farmers.

A. **Soci-economic aspects:** In Arunachal Pradesh, Monpa, a monoloid Buddhist tribe is the only tribe rearing yaks. Buddhist tribes as well as Muslim nomads raise yaks in Ladakh region. It was observed that in Sikkim Aho, Bho and Bhutia tribes (mostly Buddhists) raise yaks while in Himachal Pradesh they are raised by Buddhist tribes in Spiti and Hindu tribes in Kinnur and Chamba districts. Over the years these tribes developed traditional breeding, feeding, managemental and healthcare technologies for yak rearing which is integral part of the present day traditional yak rearing. Herding of small number of yaks is not economically viable and the owners usually offer yaks to tenant herders called as 'Brokpa'.

B. **Traditional Management Practices:** Yaks are reared under free-range system in the hills where the air, water and pasture are free from any pollution, and their produce (milk, meat, hair) are organic and just natural. In India, yaks are reared under semi migratory (transhumance) free range system. Yak keepers move their animals in a predetermined known route which is determined by the locals based on traditional knowledge. Due to interrelated constraints of high altitude yak rearing is a special zero input production system characterized with extensive management, lower efficiency and longer production cycle. However, for highlanders in remote terrain, yak is the only source of sustainable livelihood due to non-availability of arable land for major agriculture. Anatomical features of yaks viz., spacious thorax with large heart and lungs, and ability to survive on lesser oxygen has enabled this large beast to subsist and even produce at high altitude mountains, where other bovines cannot sustain. They utilize small blades of grasses on high altitude pastures and also travel long distances in snow bound areas.

C. **Seasonal migration and grazing pattern:** Traditional yak husbandry system involves migration in search of better pasture. In India and other neighbouring countries like Nepal and Bhutan, the farmers practice two-pasture utilization strategy. During summer, yaks are taken to high altitude alpine pasture (4,500 m and above). In winter, they return to pockets nearer to their villages located at mid altitude (3000m above msl). Grazing in summer pasture is from May to September while in December to February, winter pastures are utilized; the rest of the period is spent on transit from winter pasture to summer pasture.

Fig 1. Yak (*Poephagus grunniens*)

Fig 2. Chawar

Fig 3. Yak Dance

Fig 4. Churpi Preparation

Fig 5. Yak Butter

Fig 6. Milking of Yak

Fig 7. Shaa Sangbu (Dry Meat)

Fig 8. Hat made of Yak's hair

TRADITIONAL MANAGEMENT OF YAK

a. **General Management**

- **Care of calves and milking practices:** Generally yak females are not milked for first one month after calving. During this time, calf takes all the available milk. Usually, during daytime, calves graze along with the dam and continue to suckle, in night, they are separated from dam and dams are milked in the early morning. At about 12 months of age, dam and calves are separated into different herds. Milking is done by stripping as the teats are small (2-4 cm) and funnel shaped.
- **Shearing:** Yaks produce two types of fibre: coarse outer hair and fine down fibre, which grows prior to the onset of winter as additional protection for the yak against cold. The down fibre of yak is like pashmina or mohair of goats. The

fibres are utilized by herders themselves for making tents, ropes, caps etc. in a traditional way.

- **Castration:** Castration of unselected bulls is a traditional practice to avoid breeding by inferior bulls.

b. Traditional Feeding Management

In India, the yak keepers practice two-pasture utilization strategy. The summer pasture extends for about 190 days (May-October) and the winter pasture extends for about 138 to 150 days (November-April).Locally available alternative feed resources like tree fodder, agricultural by-products, coarse roughages are utilized for feeding of yaks during peak winter.

The important locally available tree fodder species commonly fed to yaks are phrengpa (Quercus wallichiana), syluli (*Acer campbellii*), salyx (*Salix humboldtiana*), blemkar (*Buddleja asiatica*), domkar (*Symplocos racemosa*), maar (*Castanopsis sp.*), bagar (*Berberis sp.*), zimbu (*Ligustrum myrsinitis*) an karsingh (*Acer hookeri*). Most of these tree fodders are deciduous in nature.

c. Traditional Breeding Management

Yaks are living in the harsh environment and unfriendly ecosystem, the natural selection has played a pivotal role in yak breeding. Traditionally, the yak herders are breeding their animals within their herds in isolated geographical boundaries. The pure breeding is the predominant practice. Under field conditions, yaks are seasonal breeders. The duration of breeding season and conception rate is mostly dependent on pasture availability and climatic conditions. The age at puberty among Indian yaks ranged 36-42 months under field conditions. The age at first service was 3 to 4 years in all the states and gestation period is about 258 days in yaks.

d. Traditional Yak Health Management

The people living in the high altitude hilly regions have been utilizing these medicinal herbs for their ailments and sufferings.

E.g. Nyan-thub (*Thalictrum foliosum*)- Roots used for treatment of inflammation and fever Ser-shing (*Barbaris sp.*)- Stem and flowers are traditionally used for treating conjunctivitis, sore mouth, infection of throat and larynx

Ngur-mo (*Drynaria sp.*) – Roots are traditionally used for treatment of herb poisoning Wang-fu-lappa (*Dactylorhiza hetegeria*) – Roots are used for the treatment of infertility and impotence of reproductive tract.

Shin-tu ug-med (*Aconitum heterophyllum*) – Used as antiseptic, antidote against snake and scorpion bite and treatment for infectious fever.

CHALLENGES OF YAK REARING

Yak husbandry is facing lots of limiting issues relating to population dynamics, nutrition, genetics, health and value addition of products which are proposed to be addressed scientifically by this institute in collaboration with line departments. Unfortunately, Indian yak owners do not get good return from yak husbandry. For example tail hair (Chammer), bones, skull and horns are important products of yak – which may be a potential source of income. Yak husbandry is facing the challenges due to transhumance system (migratory/pastoral) of farming on alpine pasture, paying grazing tax to community leader and degradation of the natural grasslands. To mitigate the issue and to enhance production potential of temperate grasses and legumes, seed production has been initiated at farm levels. Climate change is one of the biggest environmental threats affecting Yak. This has been already predicted that, average temperature will increase by 1.8 to 4 degrees Celsius by 2100. It would result in reduced crop yield by 20-40% in most of the Asian countries. Moreover, 20- 30% of species will be at risk of extinction. Due to climate change there will be emergence of trans-boundary and vector borne diseases and host-pathogen interaction will augment the emergence of unexpected events, including the emergence of new diseases and pests. The climate change may also affect the biomass availability and quality of high land pastures grazed by the yak.

CONCLUSION

Yak is the most ecologically sustainable genetic resource of the Himalayas which provides livelihood support and nutritional security for highlanders; especially, the poor tribal farmers on remote hills. They are reared on pastoral system by the tribal people on high hills where no other livestock husbandry or crop production is possible. The yaks can sustain severe cold (up to –50°C) and can travel comfortably on snow bound steep hills and hypoxic conditions. They are multipurpose animal which provide milk, meat, fibre, dung and are also useful for transportation of household goods. Thus, livelihoods of rearers are solely dependent on yaks. Traditionally, the yaks are reared under free-ranged system in the high hills where the air, water, and pasture are free from any pollution, and their products are organic and just natural. Thus, yak husbandry has lots of untapped opportunities and can be improved by collective efforts for scientific intervention, developmental activities of line departments and business entrepreneurs having immense role to play to uplift the economy of yak herdsmen in our country.

Antibiotic Resistance: A Global Crisis

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ABSTRACT

This article gives a very brief overview of the antibiotic resistance their causes, role of uses of antibiotics in veterinary medicine, measures taken to prevent resistance. Antimicrobials are probably one of the most successful forms of chemotherapy in the history of medicine, until the present-day situation, which is marred by the emergence of hard-to-treat multiple antibiotic-resistant infections. The ways of responding to the antibiotic resistance challenges such as designing more effective preventive measures and importantly, better understanding the ecology of antibiotics, role of food animals in sphered of antibiotic resistance and antibiotic resistance are discussed.

INTRODUCTION

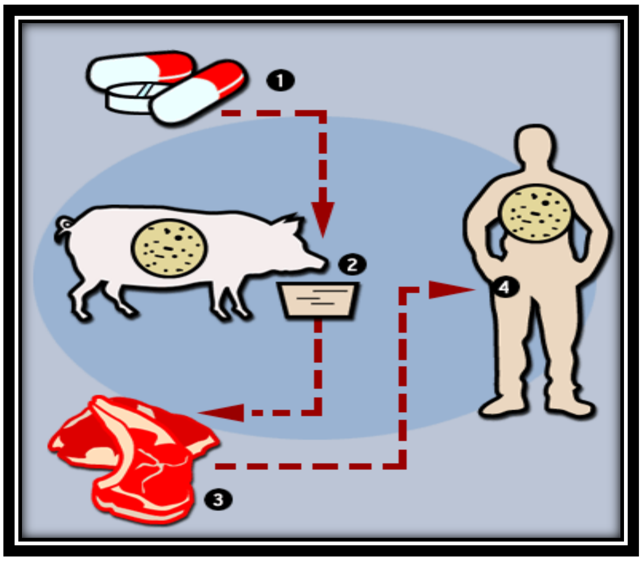
- Antibiotics are medicines used to prevent and treat bacterial infections. Antibiotic resistance occurs when bacteria change in response to the use of these medicines.
- Bacteria, not humans or animals, become antibiotic-resistant. These bacteria may infect humans and animals, and the infections they cause are harder to treat than those caused by non-resistant bacteria.
- Indiscriminate use of antibiotics in food animals and their residues in meat are of great concern because it lead to development of resistance to that particular antibiotic in human as they unintentionally underdosed.

Antibiotic:

- An antibiotic is a type of antimicrobial substance active against bacteria and is the most important type of antibacterial agent for fighting bacterial infections.
- Antibiotic medications are widely used in the treatment and prevention of infections.

Antibiotic resistance:

- ❖ Antimicrobial resistance (AMR or AR) is the ability of a microbe to resist the effects of medication that once could successfully treat the microbe.
- ❖ Resistant microbes are more difficult to treat, requiring alternative medications or higher doses of antimicrobials.
- ❖ These approaches may be more expensive, more toxic or both.
- ❖ Microbes resistant to multiple antimicrobials are called multidrug resistant (MDR).
- ❖ Those considered extensively drug resistant (XDR) or totally drug resistant (TDR) are sometimes called "superbugs".



1. & 2. Indiscriminate use of antibiotics in food animals.

3. Residues of antibiotic in meat.

4. Development of antibiotic resistance in human to same antibiotic after ingestion of meat.

- ❖ All classes of microbes can develop resistance.
- ❖ Fungi develop antifungal resistance. Viruses develop antiv iral resistance. Protozoa develop antiprotozoal resistance, and bacteria develop antibiotic resistance.
- ❖ The World Health Organization concluded that inappropriate use of antibiotics in animal husbandry is an underlying contributor to the emergence and spread of antibiotic-resistant germs, and that the use of antibiotics as growth promoters in animal feeds should be restricted.
- ❖ The phenomenon of antimicrobial resistance caused by overuse of antibiotics was predicted by Alexander Fleming who said "The time may come when penicillin can be bought by anyone in the shops.
- ❖ The danger that the ignorant man may easily under-dose himself and by exposing his microbes to nonlethal quantities of the drug make them resistant."
- ❖ Without the creation of new and stronger antibiotics an era where common infections and minor injuries can kill, and where complex procedures such as surgery and chemotherapy become too risky, is a very real possibility.
- ❖ Antimicrobial resistance threatens the world as we know it, and can lead to epidemics of enormous proportions if preventive actions are not taken.

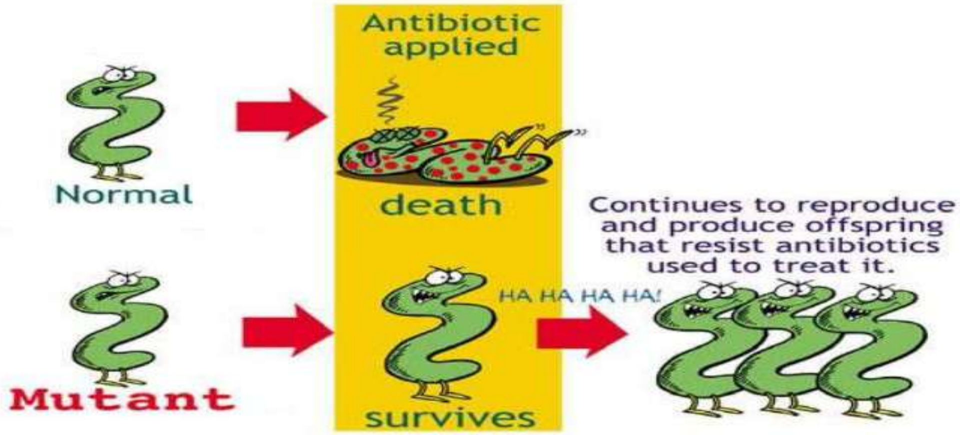
RESISTANCE ARISES THROUGH ONE OF THREE MECHANISMS:

1. Natural resistance in certain types of bacteria
2. Genetic mutation
3. By one species acquiring resistance from another.

Antibiotic resistance tests

- ❖ Bacteria are streaked on dishes with white disks, each impregnated with a different antibiotic.
- ❖ Clear rings, such as those on the left, show that bacteria have not grown—indicating that these bacteria are not resistant.
- ❖ The bacteria on the right are fully susceptible to only three of the seven antibiotics tested.

How Antibiotic resistance Develop



HAZARDS OF ANTIBIOTIC RESISTANCE

- ❖ In this day and age current antimicrobial resistance leads to longer hospital stays, higher medical costs, and increased mortality.
  - **In animals: -**
    - It leads to increased cost of treatment towards higher antibiotics.
    - Loss of neonatalanimals due incurable infection.
    - Reduced yield and growth rate due to prolonged suffering.
    - Threat of such infection to veterinarian and animal attender.

- Loss of animal due unavailability of better antibiotics and indirectly economic loss of farmer.

Guidelines for successful antimicrobial therapy

1. For definitive therapy recommend a narrow spectrum antimicrobial drug.
2. Keep the broad-spectrum drug reserved for situations where they are specifically indicated or where causative agents / sensitivity is not known.
3. Prefer bactericidal over a bacteriostatic drug.
4. Use a less toxic antimicrobial than a potentially /more toxic agent.
5. Prefer an antimicrobial that requires less frequent administration than that which is given after short intervals.
6. For less severe infections prefer an oral antimicrobial drug(except in ruminants), but for severe infections(e.g. septicaemia, meningitis)use a parental antimicrobial drug.
7. Always use antimicrobial agent in proper dose(neither higher or lower) and for proper duration of time.
8. When a combination regimen is used,all individual agents should be used in full dosage.However,do not combine antimicrobials without valid cause.
9. Select an antimicrobial only when the medical indications are clear;do not use antimicrobial therapy indiscriminately.
10. Avoid overuse f newer agents when already available agents are effective.
11. Prefer less expensive and easily available antimicrobial agent.
12. Always select an antimicrobial manufactured by a reliable pharmaceutical firm.
13. Do not use antimicrobials to treat trivial, self-limiting or untreatable infections.

Commonly used antibiotics:

Sr. no.	Name of antibiotics
1.	Enrofloxacin
2.	Ceftriaxone
3.	Penicillin
4.	Oxytetracycline
5.	Amoxicillin
6.	Ceftiofur

Preventive measures of antibiotic resistance

- Discover new drugs faster than emergence of resistance
- Promote discovery, development and dissemination of new antimicrobial agents
- Prevent emergence of resistance by reducing selection pressure by appropriate control measures
- Rationalize the use of available antimicrobial agents
- Promote discovery, development and dissemination of new antimicrobial agents

Steps taken by WHO: -

1. **World Antibiotic Awareness Week**

Held every November since 2015 with the theme "Antibiotics: Handle with care", the global, multi-year campaign has increasing volume of activities during the week of the campaign.

2. **The Global Antimicrobial Resistance Surveillance System (GLASS)**
   The WHO-supported system supports a standardized approach to the collection, analysis and sharing of data related to antimicrobial resistance at a global level to inform decision-making, drive local, national and regional action.
3. **Global Antibiotic Research and Development Partnership (GARDP)**
   A joint initiative of WHO and Drugs for Neglected Diseases initiative (DNDi), GARDP encourages research and development through public-private partnerships. By 2023, the partnership aims to develop and deliver up to four new treatments, through improvement of existing antibiotics and acceleration of the entry of new antibiotic drugs.
4. **Interagency Coordination Group on Antimicrobial Resistance (IACG)**
   The United Nations Secretary-General has established IACG to improve coordination between international organizations and to ensure effective global action against this threat to health security. The IACG is co-chaired by the UN Deputy Secretary-General and the Director General of WHO and comprises high level representatives of relevant UN agencies, other international organizations, and individual experts across different sectors.

CONCLUSION

- The world urgently needs to change the way it prescribes and uses antibiotics. Even if new medicines are developed, without behaviour change, antibiotic resistance will remain a major threat. Behaviour changes must also include actions to reduce the spread of infections through vaccination, hand washing, practising safer sex, and good food hygiene.
- Comprehensive efforts are needed to minimize the pace of resistance by studying emergent microorganisms, resistance mechanisms, and antimicrobial agents.
- Multidisciplinary approaches are required across health care settings as well as environment and agriculture sectors.
- Progressive alternate approaches including probiotics, antibodies, and vaccines have shown promising results in trials that suggest the role of these alternatives as preventive or adjunct therapies in future.

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Role of Biotechnology in improvement of Horticulture

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ABSTRACT

Horticultural crops comprise a major segment of agricultural production of a country. It covers the production of fruits, vegetables, flowers, spices, condiments, plantation crops, as well as medicinal and aromatic plants and their management and marketing. The importance of horticultural crops can be justified with its advantages over the other cereal crops like high production per unit area, high value low volume crop (spices, medicinal and aromatic crops), waste land utilization, high export value, high returns per unit area, providing of raw material for the food industry, optimal use of undulated lands, hybrid seed production and providing employment to women by available opportunities through processing, floriculture, nursery preparation, execution of landscaping plans, mushroom cultivation, etc. Apart from the economic growth, fruits and vegetables are valuable to provide energy to procure health. Thus the nation will be healthy and wealthy by adopting horticulture.

Key words: Horticultural crops, fruits, vegetables, spices, aromatic plants, landscaping

INTRODUCTION

The requirement of fruits and vegetables is increasing proportionally with the increasing population in the country. Although conventional plant breeding techniques have made considerable progress in the development of improved varieties, they have not been able to keep pace with the increasing demand for vegetables and fruits in the developing countries. Traditional sexual-breeding programs can improve some of these crops. The process can be slow, however, especially in tree-breeding programs. Another method to improve cultivars is to screen "sports" or mutations that occur naturally, but rarely, on cultivars grown in a field, greenhouse, or laboratory. In floriculture and ornamental crops, the success of variety depends on the choice of individual, which is keep on changing very fast as the conventional methods cannot compete the demand.

Therefore an immediate need is felt to integrate biotechnology to speed up the crop improvement programmes. Biotech is an innovative science in which living systems and organism are used to developed new and useful products. Biotechnological tools have revolutionized the entire crop improvement programmes by providing new strains of plants, supply of planting material, more efficient and selective pesticides and improved fertilizers. Many genetically modified fruits and vegetables are already in the market in developed countries. The major areas of biotechnology which can be adopted for improvement of horticultural crops are:

1. Tissue Culture
2. Embryo rescue is another area where plant breeders are able to rescue their crosses which would otherwise abort.
3. Genetic Engineering
4. Molecular diagnostics and Molecular markers
5. Development of Beneficial microbes
6. GM crop

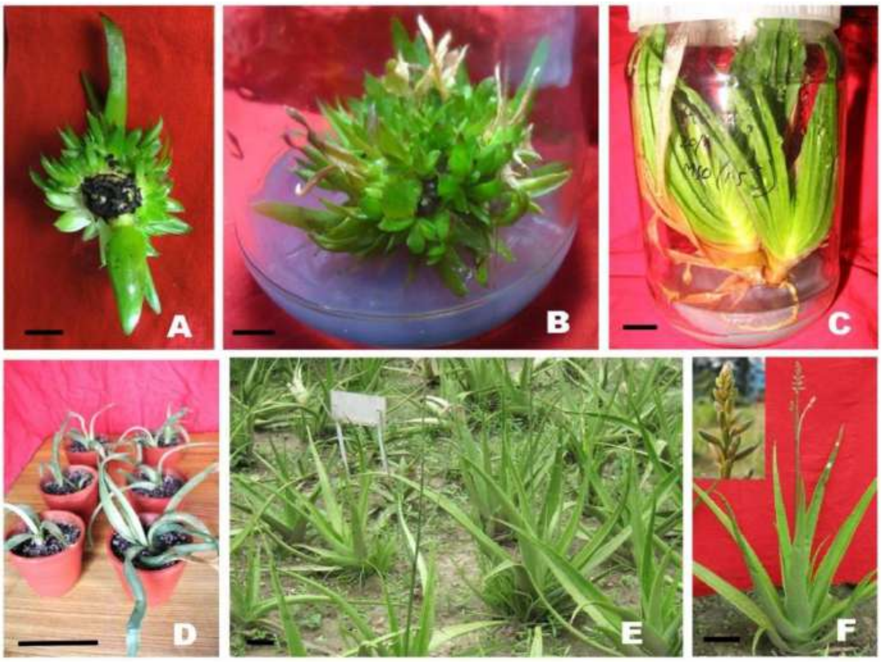
Tissue culture has been one of the main technological tools that have contributed to the 'Second Green Revolution and Gene Revolution'. In tissue culture, whole plants can be developed from single cells under the proper stimuli of growth regulators, growing medium, and light. This technique is economical in time and space affords greater output and provides disease free and elite offsprings. The Indian scenario of tissue culture industry clearly indicates that it is a flourishing industry with about 125 tissue culture units with a total production capacity of 300 million plants per annum currently. The Government of India has identified micropropagation industry as a priority area for further research, development and commercialization. Department of Biotechnology, Government of India, will set up 50 Biotech Laboratories in Senior Secondary Schools of Arunachal Pradesh under the scheme Biotech Labs in Senior Secondary Schools (BLISS) to encourage young dynamic students. Rs. 75 to 100 crores have been earmarked for the implementing the projects.

Some horticultural crops where tissue culture techniques have been perfected:

a) **Fruit crops**: Banana, citrus, grape, pineapple, sapota, strawberry etc.
b) **Vegetables and tuber crops:** Potato, sweet potato.
c) **Ornamentals:** Anthurium, carnation, gerbera, lilies, orchids, syngonium, rose, chrysanthemum, ficus etc.
d) **Spices:** Black pepper, large cardamom, small cardamom, ginger, Kalazira, turmeric, saffron etc.
e) **Medicinal and aromatic plants:** Aloe vera, dioscorea, geranium, neem, pachouli, stevia sp. etc.
f) **Plantation crops**: Tea

It was surveyed for the year 2007-08 the overall market demand for tissue culture plants would be 145 million plants of the above species valuing Rs. 136 crores, with a growth rate of 20-25%. The consumption of plants for 2002-03 has been approximately 45 million plants with banana constituting 41% share followed by sugarcane at 31% and ornamentals at 14%, spices at 6% and medicinal plants at 4%. When it comes to the international demand, the foliages and ornamentals have a great potential and the products have an unending elongated list. Major pot plants and landscaping ornamentals like Ficus, Spathiphyllums, Syngoniums, Philodendrons, Nerium, Alpenia, Yucca, Cordylines, Pulcherrima, Sansevieria, Gerbera, Anthuriums, Rose, Statis, Lilies, Alstromeria etc. are routinely produced by various plant tissue culture laboratories in India. In countries like Australia and Central America, bananas are always cultivated with tissue cultured plants after indexing for virus. The productivity of banana in India through conventional method was 15 kg /plant and by replacing the conventional methods of use of suckers with tissue cultured plantlets, the productivity can be enhanced to about 50 kg/plant from the same area. Development of a cardamom variety through tissue culture yielding 250 kg/ha, which can be cropped in two years, compared to conventional grown plants yielding 70 kg/ha and maturity in 3 years. In vanilla crop, high glucovanillin-producing, early-flowering plants have been developed. Micro tuber production in potato has been scaled-up using the bioreactor technology at Hindustan Lever Ltd., Mumbai.

Other global countries involved in Tissue Culture plants production include European countries, USA, Canada, Australia, New Zealand, Israel, Middle East, South and Central America and Africa. In USA, chrysanthemum and carnations are commercially produced in the tissue culture lab. Majority of all commercially produced strawberries are developed from plantlets produced in tissue culture lab in European countries.



Different stages of Micropropagation and field performance of Aloe vera

Another aspect of plant tissue culture is to produce somaclonal variation which means to generate genetic variations that may be needed in breeding program. In different crops like potato- improvement of tuber shape, colour and uniformity, and late blight resistance; tomato - increased solids, resistance to Fusarium race 2 were developed. In the ornamental sector, 22 new cultivars of Syngonium were developed through variations. Similarly, Labland Biotech, Mysore has obtained one unique, stable variant of Spathiphyllum which is being registered as the new variety named 'Sona' and is being multiplied commercially for both domestic and overseas market in large numbers. Among the other agricultural crops, CIEN BTA-03, a variant of Williams variety of Banana resistant to yellow Sigatoka disease, Bio-13 a variety of Citronella released by CIMAP, India. The first transgenic crop to reach the market was the Flavr Savr tomato, and sweet corn, potato, squash and papaya varieties engineered to resist insects and viruses have been approved for commercial use and marketed, papaya is the only horticultural crop for which transgenic varieties have achieved a significant market share (about 70% of the Hawaiian crop shipped to the continental United States is transgenic).

The Division of Biotechnology focuses on research on specific areas which includes, gene discovery, regeneration and development of transgenic, molecular markers, marker assisted selection, functional genomics and bioinformatics. Some major achievements are:

- Development of molecular markers for okra and markers for root-stock identification in citrus.
- Development of BT transgenic brinjal and tomato
- Cloning of genes for fungal resistance and transgenic development
- Development of embryogenic suspension of banana and GM banana for Fusarium wilt resistance
- Development of GM tomato, papaya and watermelon for virus resistance
- Development of commercially feasible micropropagation protocols of clonal rootstocks of apple Malling- Merton series (M7, MM106, M26, MM111 and Merton793).
- Development of resistant lines of apple rootstock Malling 7, to white root rot caused by *Dematophora necatrix* through in vitro selection.
- Protocols for micropropagation of various horticultural crops which includes fruit crops, ornamentals and medicinal plants have been developed.
- Molecular tagging of genes for resistance to black rot and stalk rot in cabbage and cauliflower has been achieved.
- QTL analysis has been carried out in cabbage for resistance in cabbage.

List of ongoing Projects:

S.No.	Title of Project	Funding Agency
1.	"Establishment of virus free elite mother block of apple in the tribal areas of Kinnaur and Lahaul Spiti in Himachal Pradesh"	DST funded project

2.	Refinement for optimization of in vitro rooting and acclimatization of micropropagated plants of clonal rootstocks of stone fruits.	CPRI/ICAR,New Delhi.
3.	Biotechnological interventions for establishment of own rooted progeny orchard of some stone fruit.	DBT, New Delhi,
4.	Germplasm characterization of model species and assessment of cross-species SSRs transferability in pome and stone fruit crops of family Rosaceae.	DST, New Delhi

ROLE OF GOVERNMENT IN PLANT TISSUE CULTURE INDUSTRY

To encourage the tissue culture industry, various central and state government departments have framed several schemes and have announced incentives.

(a) Ministry of Agriculture: The Department of Agriculture and Cooperation under the Ministry of Agriculture, Government of India provides financial assistance up to Rs. 21 lakhs and Rs. 10 Lakhs for setting up tissue culture units in public and private sectors respectively, subject to a maximum of 20% of the project cost. Under integrated development of fruits scheme, financial assistance in the form of subsidy, up to 50% is provided for purchase of tissue culture banana plants by various state Governments. The Government of India has set up a national facility for virus diagnosis and quality control of tissue culture plants at New Delhi with 5 satellite centres catering to the needs of the tissue culture industries in various parts of the country.

(b) Agriculture and Processed Food Products Export Development Authority (APEDA): Under the Ministry of Commerce and Industry, state-of-the-art airfreight trans-shipment centre has been set up for tissue culture plants (perishables) at New Delhi, Bombay and Bangalore airports. Airfreight subsidy up to 25% of the freight cost is provided to tissue culture plants. 50% subsidy is given for the development of infrastructure like refrigerated van, packing, export promotion, market development, consultancy services, feasibility studies, organization building and human resource.

(c) National Horticulture Board (NHB): For setting up tissue culture lab there is a provision for back-ended capital subsidy not exceeding 20% of the project cost with a maximum of Rs. 25 lakh per project. Such subsidies are also extended to build up greenhouse and climate controlled poly house/shade house.

(d) Small Farmers Agri-business Consortium (SFAC): SFAC under the Ministry of Agriculture gives soft loans up to 50 lakhs for setting up small tissue culture labs by co-operative societies formed by small scale farmers.

(e) Department of Biotechnology (DBT): DBT supports research and development projects across the country at various laboratories in the universities and research institutions for development and standardization of tissue culture protocols. The private tissue culture units are entitled for expansion of existing units as a Phase II activity under a scheme called Small Business Innovation Research Initiative (SBIRI). To promote the adoption of tissue culture technology by the industry and the end user, the department has established two micropropagation technology parks (MTPs) which provide a large number of service packages and have an important mandate of training and generating skilled manpower. The MTPs have transferred about 10 technologies to the industry and have also provided consultancy and taken up turn-key projects for various end users and state departments. The department has also set up a national facility for virus diagnosis and quality control of tissue culture raised plants, which are located at 6 different centres in India to ensure supply of disease free plants to the end users.

(f) State level incentives: The states of Karnataka, Gujarat, Maharashtra, and Andhra Pradesh are giving financial assistance for setting up tissue culture units under the new agro-industrial policy. Karnataka gives capital subsidy of 20% on investments. All the above schemes have encouraged the establishment of tissue culture industry, which in turn have tremendously improved the demand for tissue culture generated quality planting material. A concerted effort is being made by the Government and the Industries to ensure that plant tissue culture, a technology with enormous commercial potential, would be an important industrial activity during the 21st century.

Public and private sector collaboration

Establish new models for academy-industry partnerships. The public institutions have the expertise while the private sector units have the commercial temper, money and mind set to market viable products, which are needed to foster speedy delivery of technology. Bt brinjal is an indigenous product developed by India's leading seed and biotech company Mahyco in collaboration with public sector institutions. South-South collaboration in biotechnology is evident from the fact that developing countries see biotech as an important tool to improve agriculture, to provide job opportunities and increase income of poor farmers. More importantly, there is an increasing need to address various concerns, share knowledge and experiences from major biotech countries that are reaping benefits, and also to create awareness about safety and benefits of biotechnology among farmers, consumers and the public alike. As a first step in that direction, India has already responded to the need of two Asian countries. Based on their request, Mahyco has transferred FSB (fruit and shoot borer) resistant Bt brinjal technology to public sector institutions in Bangladesh and the Philippines. The transfer of this technology to the Institute of Plant Breeding of the University of Philippines, in the Philippines and Bangladesh Agricultural Research Institute (BARI) and East West Seeds Ltd., in Bangladesh materialized under the aegis of the Agricultural Biotechnology Support Project (ABSP II) of the Cornell University, which is supported by the United States Agency for International Development (USAID). Mahyco has generously donated Bt brinjal technology for the development of pro-poor varieties of brinjal to benefit fellow citizens of Bangladesh and the Philippines.

Awareness and Education

Public awareness of risks and benefits of biotechnology is very low and is largely based on misinformation. Public acceptance of transgenic products needs vastly enhanced awareness of the benefits and safety of technology. Educating the public on the benefits and safety of GE products should be based in science avoiding the emotional and ethical platform. It is also necessary that social, economic and political issues are not mixed up with science. Launch or support extensive awareness and education programmes involving the general public, media, judiciary and Government departments that formulate, implement and monitor policy. It would be necessary to organize these programmes in different states, at the district level and in the concerned local language. Farmer education should be an important component of this effort.

Lack of Government focus

Biotechnology offers a high promise for improvement of Indian agriculture. The Ministry of Agriculture has a very important role to play in the deployment of biotechnology in agriculture. Along the way, somewhere, the Ministry lost the initiative in this regard and appears to an outsider, to be playing only a secondary role. The Ministry should regain the total control of this important area of its responsibility, set policy and implement it with the rigor it deserves.

Challenges and suggestions

A number of technical, economic, regulatory and market factors have combined to create hurdles for the utilization of biotechnology in horticultural crops, which are more diverse than field crops. Because of the limited size of the individual markets, the costs of gaining access to patented genetic-engineering methods and meeting the regulatory requirements for testing and registration of biotech crops represent substantial economic hurdles for horticultural products. At the same time, consumer concerns and the related reluctance of food processors and marketers to accept new biotech commodities are delaying the introduction of horticultural products already developed, acceptance of GM food, lack of trained man power and laboratories extension services, lack of awareness among farmers. These barriers are exacerbated by the globalization of fresh produce markets and the growing dominance of large supermarket chains, as exporters must meet diverse regulatory requirements in different countries and specific standards set by multinational food marketers. A clear policy document on GEOs in agriculture is needed.

CONCLUSION

The approval of new applications of transgenic crops, an increasing number of government departments, biosafety and marketing proving an impediment to the commercialization of transgenic technology is said to be a future strategy to solve the problem of poverty, malnutrition and hunger. Systematic R&D efforts aimed at commercialization of product and process may go in a long way in promotion of horticulture industry in the country and to enhance India's capability to compete globally. Continue projects/ programme mode support to some extent with certain modification or revisions of funding guidelines for the social sector. The other programmes for the upliftment of rural people will be taken up in the areas such as medicinal & aromatic plants, mushroom cultivation, horticulture, sericulture, application of bio-fertilizers & bio-pesticides, and floriculture.

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Biological weed control: A way to sustainable weed management

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Weeds are the biggest nuisance in crop cultivation and causes huge economic losses to the farmers which makes weed management a very important aspect for successful raising of crops. Various control measures viz. cultural, mechanical and chemical measures are employed by farmers so as to maintain the weeds population below threshold level. The Cultural and mechanical methods which mainly includes hoeing and hand weeding are very laborious and time consuming and unavailability of labour in peak seasons further worsen the problem. Although, application of herbicides exhibits quick knockdown effect, thereby, making it very economical and efficient measures for controlling the weeds population, but due to its environmental concerns like buildup of herbicide residue in soil thus, entered in food chains make this method quiet hazardous to human health. Therefore, biological control of weeds using insects, plant pathogens and other living organisms or their products has been considered as eco-friendly and sustainable alternative to the management of weeds. Biological control is especially useful in natural areas, forests, rangelands and aquatic water bodies, where very high specificity, low costs and permanent control are needed to reduce populations of an invasive exotic weed without harming the native species. First unintentional biological control in the world happened in India where cochineal insect, *Dactylopiusc eylonicus* was mistakenly introduced from Brazil in place of *D. cacti* to produce dye from *Opuntia vulgaris* during 1795. In due course, it started to control *Opuntia*, which led to the foundation of biological control of weeds in future. Systematic biological control research in India started in 1957 with the establishment of Commonwealth Institute of Biological Control (CIBC) at Banglore and followed by establishment of All India Coordinated Research Project on Biological Control of Crop Pest and Weeds (AICRP-BC&W) in 1977. Meanwhile, Directorate of Weed Research (DWR) earlier named as National Research Centre for Weed Science (NRCWS) came into being in 1989 at Jabalpur and deals with issues linked to weed management and includes biological control of weeds in India. Under classical biological control, exotic natural enemies are introduced against inadvertently introduced alien organisms, which have become pests in the lack of natural checks. So far in India, 31 exotic biological control agents have been introduced against weeds, of which 22 were recovered and established, 6 could not be released in the field while 4 could not be recovered after release. From these established bioagents, 7 are providing excellent control, 4 substantial and 9 partial controls (Singh 2004 and kumar 2015). It was recorded that under classical biological control in India, highest degree of success was achieved in biological control of acquatic weeds (55.5%) followed by homopterous pest (46.7%) of crop pest and terrestrial weeds (23.8%).Some examples of successful biological weed control are listed as-

S. No.	Exotic natural enemy	Country/year of introduction and weed plant
1.	*Dactylopiusc eylonicus*	Brazil, 1795, against*Opuntia vulgaris*
2.	*Dactylopius opuntiae*	USA via Srilanka via Australia, 1926, against *Opuntia stricta*
3.	*Zygogramma bicolorata*	Mexico, 1983, against *Parthenium hysterophorus*
4.	*Neochetina bruchi* and *Neochetina eichorniae*	Argentina via USA, 1983, against *Eichornia crassipes*
5.	*Crocidosema lantana*	Hawaii, 1902, against *Lantana camara*
6.	*Cyrtobagous salviniae*	*Salvinia molesta*

ADVANCES IN BIOLOGICAL WEED CONTROL IN INDIA:

- **Development of bio-herbicides-** Bioherbicides are the liquid formulation of microbes like fungi, bacteria, viruses and virus like agents that are spayed on weed population in similar manner as of chemical herbicides.Among them fungi has been used widely and isolates of fungal propegules are known as mycoherbicides. Several microbial products have been patented and commercialized in well advanced countries like Devine developed in USA, was first commercial mycoherbicide derived from fungi *Phytophthora palmivora*. The work on microbial approaches in India is mainly limited to *Parthenium* and aquatic weeds.
- **Phytotoxinsfrom plants-** Plants produce an incredible diversity of low molecular weight organic compounds known as secondary metabolites or allelochemicals. The phenomena of allelopathy can be practically utilised for weed control in the form of crop rotations, intercropping, allelopathic mulches and spray of allelopathic plant water extracts. Application of sorghum and sunflower extracts reduced weed biomass by 33-53% and increased wheat yield by 7-14%. Number of synthetic herbicides is derived from these phytotoxins such as herbicide mesotrione is derived from leptospermone, a compound isolated from bottle brush plant and used for killing of weeds in maize crop.
- **Phytotoxic metabolites from microbes-** Plant pathogenic fungi and bacteria produce a wide array of metabolites including alkaloids, glycosides, peptides,

phenolics, terpenoids with wide range of ecological and industrial utility. These metabolites can be exploited for their use as weed control and offers best alternative to chemical herbicides. Fungal species like *Alternaria, Penicilium* and *Fusarium* biosynthesizes more than 130 bioactive compounds. A few companies in India claim the successful formulation of the product from the isolates of fungi against *Parthenium* and water hyacinth, but large scale field application is still awaited.

- **Amalgamation of biological methods with chemical measures-** Utilisation of biological measures alone for controlling the weeds require a very long time. However, if it is performed in conjunction with chemical measures, the knockdown timings are reduces effectively. Like, biological control of water hyacinth using *Neochetina* spp. Alone take considerable long time ranging from two to three years, however chemical and biological integration may significantly reduce the time of control. A demonstration was conducted at DWR, Jabalpur by Kumar (2011) in a pond by releasing of about 1000 adults of *Neochetina* spp. In one part of the pond and spraying of the herbicides in other parts of the pond in 15% area. First cycle of control was achieved within 9 months. This early collapsed of the weed within a period of 9 months could be possible due to integration of herbicides and bioagents, which would otherwise have taken minimum 2-3 years by the bioagents alone.

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Prevention and Control Steps for Dairy Farm Owners during Covid19 Lockdown Period

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We have realized that this is a challenging time for everyone, filled with stressful conditions and new constraints on business. Dairy farming and supporting agriculture businesses are considered essential and can continue to operate as normal.The cooperative network in India continues to feed the country as well as millions of dairy farmers during the lockdown.Small and large milk cooperatives like Mother Dairy, Amul, Sumul, Banas,Nandini,Parag and several continued to procure surplus milk from farmers and ensured an uninterrupted milk supply in this time of crisis. However at the same time the round the clockwork by the dairy farmers and the operational dairy farms necessitated some basic precautionary measures to be adopted by the dairy managers and dairy owners

- Restrict the entry of outside people and maintain visitor's log. Keep a record of all visitors who interact with your workers.
- Footbaths should be used at entry point of farm, milking parlour and sheds which shall help disinfect all the vehicles and persons entering the farm
- In India the daily workers or the employees at your farm are mostly illiterate. Talk with your employees about coronavirus, how it spreads and how to prevent getting infected. Ask them to avoid close contact with sick people, both on and outside of your dairy.
- As a part of awareness guidelines keep some image photographs and posters showing the mode of transmission of the infection.
- Strength of farm workers/ animal shed attendants should be minimized.
- If possible the workers or farm employees can be called on rotation basis.
- The workers should be asked to maintain social distancing while performing group activities like milking, cleaning animal sheds and utensils and feed and fodder distribution
- The milkers should be asked to wear milking gloves and also change them frequently

- Workers coming to livestock farms should wear masks. Some better organized farms can opt for thermal scanning or asked for their health on daily basis.
- The workers should be advised to wash hands often with soap and water for at least 20 seconds. If soap and water are not available, use an alcohol-based hand sanitizer.
- Keep an eye on sick leave policy. Advice sick people/workers to stay home
- During these difficult times tryto provide paid sick leave for your employees otherwise the employees feel financially obligated to come to work even if they are sick
- Set up daily and weekly cleaning schedules at your farm.Clean and disinfect your workplace.
- The employee breakroom and bathroom are potential sources for virus transmission.
- Clean and disinfect any areas where employees congregate or routinely touch items such as doorknobs and computer keyboards..As far as possible keep soap, bucket of water and hand sanitizer at the entrance of the animal shed and instruct all human resources at livestock farms, to sanitize exposed body parts regularly at an interval of 1 to 2 hour with appropriate sanitizer/wash with soap.
- Clean and disinfect frequently touched objects and surfaces. like animal farm equipment,milking pails and utensils, milking measures, buckets and accessories
- Workers should be discouraged from bringing /using of mobile phones. If used phones should be frequently sanitized.
- High touch points should be cleaned twice daily by mopping with 1% hypochlorite solution. In case of metallic surfaces where bleach is not suitable 70% alcohol should be used.
- Prepare your disaster contingency plan. The plan may include whatyou will do if 50% of your employees become sick and unable to work. What if you don't have accessto feed and fodder for 15-20 days etc during the lockdown period. Always have dry feed and concentrate reserve at the farm
- Provide cleaning supplies such as cleaning solutions, buckets, mops, brushes, etc for cleaning at work and for those living in employer-provided housing.
- Download the" ArogayaSetu app" and also ask the employees to download the app if they are using an android mobile

Physical characteristics of Honey and their analysis techniques

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The physical characteristics of honey are governed by its major and minor constituents which are liable to change depending upon the available bee flora from which honey bee collect nectar. These characteristics are important for quality parameters of honey for storage and marketing purposes. The methodology for determining these characteristics has been described which is prescribed by the Bureau of Indian Standards / Indian Standard Institute, 1974 and 1977 (BIS /ISI : 4941-1974; IS8464-1977 given hereunder):

PHYSICAL CHARACTERISTICS OF HONEY

Moisture content and Refractive Index: Moisture (% by weight) is determined by the refractometer. The refractometer readings of the honey is determined at 20 ^{0}C and the moisture is calculated as per ISI (1974).

Specific Gravity : The specific gravity of honey is determined following the hydrometer method of "Honey Testing Kit" (Testing Bulletin no 27 ; August, 1989) published by Directorate of Beekeeping, Central Bee Research and Training Institute, Pune. A west – Germany made hydrometer of 1.000 to 2.000 range is placed in vertical position in the honey at 20^{o}C without touching the container. The reading on the hydrometer where the uppper layer of honey touched it , is noted and taken as the specific gravity of the honey.

Pollen density : The pollen grains in the honey samples are counted by using centrifuge and haemocytometer (ISI,1977).

Optical Density: The optical density of the honey is determined by the 'Colorimeter method' without dilution of honey (Townsend, 1969) and on w /v basis (ISI,1977).

pH : The pH is determined for 20 per cent honey solution on w/v basis using Elico pH meter. For this, 2g honey is weighed and dissolved in 10 ml distilled water. The pH is directly read on the digital screen of the pH meter.

Isolation of Yeasts: Ten gram honey is mixed with 90 ml of water in 250 ml conical flask. This is plated on the isolation media using spread plate method. Each dilution is plated in triplicate. The isolation media used is Yeast Extract Peptone Dextrose Agar (YEPDA) prepared as follows:

Yeast Extract = 10 g/l
Peptone = 20g /l
Dextrose = 20 g /l
Agar = 25 g/l
Ph = 5.0

To all above media constituents, 100 mg/l streptomycin is added as an antibacterial agent. The media, alongwith tubes, water and tips are autoclaved at 15 PSI for 15 minutes. The plates are incubated at 35±1^{0}C and the observations are taken after 72 and 96 hours.

Colour: The colour of the honey is determined on the basis of optical density. The colour class is determined using table given by Townsend (1969).

Morpho-Types of Pollen: In honey, the pollen sendiment prepared for pollen count is also examined separately under microscope for different morpho types of pollen to have an idea of the number of pollen sources of different shapes and sizes, present in each sample are separated carefully. The microscopic glass slides of individual pollen grains of different types are prepared for each sample following Sawyer (1981).

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An overview of Phases of Atma-nirbhar Bharat Abhiyan

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Honourable Prime Minister Narendra Modi's pledge of a total spending of Rs 20 lakh crore to weather the fallout of coronavirus pandemic is among the largest economic stimulus package announced by nations around the world. Modi's Atma-nirbhar Bharat Abhiyan or Self-reliant India Mission is about 10 per cent of India's GDP in 2019-20 and would rank behind Japan, the US, Sweden, Australia and Germany. Package to cater to various sections including cottage industry, MSMEs, labourers, middle class, industries, among others. Bold reforms across sectors will drive the country's push towards across sectors self-reliance. Five pillars of Atma-nirbhar Bharat – Economy, Infrastructure, System, Vibrant Demography and Demand System. It is time to become vocal for our local products make them global.The Five phases of Atma-nirbhar Bharat are:Businesses including MSMEs, Poor, including migrants and farmers, Agriculture, New Horizons of Growth, Government Reforms and Enablers.

Phase: I-Businesses including MSMEs

1. Rs. 3 lakh crores collateral free automatic loans for business, including Micro Small Medium Enterprises 2. Rs. 20,000 crore subordinate debt for MSMEs 3. Rs. 50,000 cr equity infusion through MSME fund 4. New definition of MSMEs 5. Global tender to be disallowed uptoRs. 200 crores 6. Other interventions for MSMEs 7. Rs.2500 crores EPF support for businesses and workers for 3 more months	8. EPF contribution reduced for business & workers for 3 months –Rs. 6750 crores 9. Rs 30,000 crores liquidity facility for NBFC/HCs/MFIs 10. Rs. 45,000 cr partial credit guaranatee scheme 2.0 for NBFC 11. Rs 90,000 cr liquidity injection for DISCOMs 12. Relief to contractors 13. Extension of registration and completion date of real estate projects under RERA 14. Rs 50,000 or liquidity through TDS/ TCS reductions 15. Other direct tax measures

Phase: II-Poor, including migrants and farmers

1. Direct Support to Farmers & Rural Economy provided post COVID
2. Liquidity Support to Farmers & Rural Economy provided post COVID
3. Support for Migrants and Urban Poor during last 2 months
4. MGNREGS support to returning Migrants
5. Labour Codes - Benefits for Workers
6. Free Food grain Supply to Migrants for 2 months
7. Technology Systems to be used enabling Migrants to access Public Distribution System (Ration) from any Fair Price Shop in India by March 2021 - One Nation One Ration Card
8. Affordable Rental Housing Complexes (ARHC) for Migrant Workers / Urban Poor
9. Rs. 1500 crores Interest Subvention for MUDRA-Shishu Loans
10. Rs 5000 cr Special Credit Facility for Street Vendors
11. Rs 70,000 crore boost to housing sector and middle income group through extension of Credit Linked Subsidy Scheme
12. Rs 6000 crore employment push using CAMPA (Compensatory Afforestation Management & Planning Authority) funds
13. Rs 30,000 crores Additional Emergency Working Capital Funding for farmers through NABARD
14. Rs 2 lakh crore Concessional credit boost to 2.5 crore farmers through Kisan Credit Cards

Phase: III- Agriculture

1. Rs 1 lakh crore Agri Infrastructure Fund for farm-gate infrastructure for farmers
2. Rs 10,000 crores scheme for Formalisation of Micro Food Enterprises (MFE)
3. Rs 20,000 crores for Fishermen through Pradhan MantriMatsyaSampadaYojana (PMMSY)

4. National Animal Disease Control Programme
5. Animal Husbandry Infrastructure Development Fund - Rs. 15,000 crore
6. Promotion of Herbal Cultivation: Rs. 4000 crore
7. Beekeeping initiatives –Rs 500 crores
8. From Tomatoes, Onion and Potatoes (TOP) to ALL fruits and vegetables - Rs 500 crores
9. Governance & Administrative reforms in i. Amendments to Essential Commodities Act to enable better price realisation for farmers ii. Agriculture Marketing Reforms to provide marketing choices to farmers iii. Agriculture Produce Price and Quality Assurance

Phase: IV- New horizons of Growth

1. Policy Reforms to fast-track Investment –Effort towards AtmanirbharBharat
2. Upgradation of industrial infrastructure
3. Policy reforms- Introduction of commercial mining in coal sector
4. Policy Reforms –Diversified Opportunities in Coal Sector -Investment of Rs 50,000 cr
5. Policy Reforms –Liberalised Regime in Coal Sector
6. Enhancing Private Investments in the Mineral Sector
7. Policy Reforms – Mineral Sector
8. enhancing self-reliance in defence production
9. Policy Reforms – Defence production
10. Reduction in Flying cost Rs. 1000 crores -Efficient Airspace Management for Civil Aviation
11. More World-class Airports through PPP
12. India to become a global hub for Aircraft Maintenance, Repair and Overhaul (MRO)
13. Tariff policy reform
14. Privatisation of distribution in UTs
15. Boosting private sector investment in Social Infrastructure through revamped Viability Gap Funding Scheme -Rs8100 crores
16. Boosting private participation in Space activities
17. Atomic energy related reforms

Phase: V- Government reforms and enablers

1. Health Related Steps taken so far for COVID containment
2. Reforming Governance for Ease of Doing Business
3. Recent Corporate Law measures to boost Measures for Ease of Doing Business
4. Technology driven Systems -Online Education during COVID
5. 40,000 crores increase in allocation for MGNREGS to provide employment boost
6. Decriminalisation of Companies Act defaults
7. Supporting State Governments & promoting state level reforms

DIGITAL INDIA AATMANIRBHAR BHARAT INNOVATE CHALLENGE

MeitY in partnership with Atal Innovation Mission – NitiAayog launches Digital India AatmaNirbhar Bharat Innovate Challenge to identify the best Indian Apps that are already being used by citizens and have the potential to scale and become world class Apps in their respective categories. This Innovation Challenge with various cash awards and incentives of featuring Apps on Leader Boards seeks to create an ecosystem where Indian entrepreneurs and Startups are incentivised to ideate, incubate, build, nurture and sustain Tech solutions that can serve not only citizens within India but also the world. The Mantra is to Make in India for India and the World.

The AatmaNirbhar Bharat App Innovation Challenge is being launched in the following 8 broad categories: Office Productivity & Work from Home, Social Networking, E-Learning, Entertainment, Health & Wellness, Business including Agritech and Fintech, News and Games. The central government announced the results for nine categories under the challenge, which was announced by Prime Minister Narendra Modi on July 4, 2020.

According to official communication, the App Challenge was launched on MyGov, the citizen engagement platform of the Government of India. As many as 6,940 entries from tech entrepreneurs and start-ups across the country took part in it. Out of that 24 mobile apps emerged as winners

CONCLUSION

The clarion call given by the Hon'ble PM to use these trying times to become Atmanirbhar (self-reliant) has been very well received to enable the resurgence of the Indian economy. The economic crisis triggered by Covid-19 pandemic is much like the 1991 economic crisis, which was a harbinger of a paradigm shift via liberalisation, privatisation and globalisation. The post-Covid-19 era may usher in unprecedented opportunities provided the implementation deficit is adequately addressed.

Mite infesting Coconut: Eriophyid mite (*Aceria guerreronis Keifer*)

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ABSTRACT

The coconut mite, *Aceria guerreronis* Keifer, has spread to most coconut production areas worldwide and it has been considered one of the most notorious and important pests of coconut fruits in many countries including India. Though it occurrence in the country was reported to its spread to all major coconut growing regions of peninsular India causing heavy economic loss to coconut industry. Great advances about our knowledge on coconut mite and its control have been achieved, especially in the last decade. This paper brings together information on coconut mite pest description, biology, dispersal, population dynamics, symptoms and injury, control strategies and new perspectives for its control.

Keywords: Biology, Coconut mite, Control strategy, Damage symptoms, Dispersal

INTRODUCTION

Several palm species have been developed into crops over the centuries, one of the most important being coconut (*Cocos nucifera* L.) (Howard et al. 2001). Probably due to the wide dissemination of coconuts around the globe, many coconut pests also became widely distributed. However, new invasive pests associated with coconut have been of concern during the last decades, including the coconut leaf beetle, the palm red mite, and the coconut mite, *Aceria guerreronis* Keifer. This phytophagous mite has spread to most coconut production areas worldwide and it has been considered one of the most notorious and important pests of coconut fruits in many countries.

Pest description

Adult female mites is very minute, measuring 205-255 μ in length and 36-52 μ in width (Keifer, 1965) and have slender and vermiform body which is creamy white in colour having only two pairs of legs placed near the anterior end - in the adult as well as the immature stages. The body is distinctly divided into a short cephalothorax covered over dorsally and on the sides by a shield and longer tapering abdomen, with annu1ation which may or may not show any dorso-ventral differentiation. An anteriorly projecting or down curved rostrum, with needle or lancet like chelicerae is present. Genital opening is transverse and located ventrally more towards the anterior end of body, just behind the coxae of second pair of legs. Body setation is reduced to the minimum and is very characteristic.

Eggs are shiny white and spherical in shape measuring 58.0 ± 2.40 µm in length and 29.00 ± 1.60 µm in width and generally laid in groups. They hatch in less than two weeks into young mites that may take approximately two weeks to a month to mature into adults. The larva after hatching from the egg looks like a tiny adult which moults into a nymph.

Nymph: Two nymphal statge; Protonymph are white coloured with two pairs of legs and is about 47.6 µm in length and 23.8 µm in width. Protonymph passed through the quiescent stage, by holding on to the perianth surface before moulting into deutonymph. Deutonymph are elongated white colour with two pairs of leg measuring 138.4 µm in length and 26.3 µm in width. Protonymph and deutonymph, lacks genital organs instead of that genital setae. The last juvenile stage moults into an adult mite.

Biology

Each female can lay approximately 100-150 eggs. It takes about 7-10 days to complete one life cycle from egg to adult (Mohanasundaram *et al*., 1999; Haq, 2001). The egg, first and second larval instar lasts about 3, 2 and 2 days, respectively. Several generations may occur throughout the growing season. Mites are usually found under the bracts of fertilized female flowers and do not infest the unfertilized flowers. The distribution of eriophyid mite colony is not uniform inside the perianth. Normally in two or three places the mite colonies are congregated under the tepals. In most of the cases old and fresh colonies are found beneath the fourth tepal. Each colony contains hundreds of eggs, larvae, nymphs and adults. Both nymphs and adults cause damage. The colonies may vary in size and shape. After causing damage in a particular spot/area the mites tend to move to fresh areas in the meristematic tissue and start colonization.

Ecology / population dynamics

The mite populace was observed during the time on the young developing buttons. Most extreme mite populace was recorded during summer months and least during the rainy months. All coconut varieties/germplasm and nut colour were harmed by this mite. Longer times of dry season brought about more noteworthy yield loss because of the pervasion of eriophyid mite, since fruit development is slower during dry periods. Nuts in coconut palms of any age were found to be affected by mite. Well fertilized tree were found to experience the less damage by this mite. Damage of *A. guerreronis* increased with increase in N levels and decreased with increase in K levels.

Mode of dispersal

Maximum activity of mite was observed between 6:00 and 9:00 a.m. which helps spreading very fast to the nearby coconut palm as dispersal is mainly through wind (Moore and Howard, 1996; Ramarethinam and Marimuthu, 1998) and through other insect visitors. Different stages of mite are seen in the tepals of perianth and tender portion of developing nuts. Mite population is seen to be higher in summer.

Nature of damage:

- The earliest symptom on 2-6 month old buttons initially appears as a triangular brownish patch at the level of the perianath and as the nut grows, a number of such BTP (brownish triangular patch) appears on the nut which ultimately leads to warting and longitudinal fissures on the nut.
- Draining of the sap from young buttons led to yellow discolouration which gradually turned into brown colour resulting affected buttons may fall. As the buttons grow, brown patches lead to black necrotic lesions with longitudinal fissures on the husk and "T" shaped split may also develop.
- Affected nuts results oozing of the gummy exudation from the surface (Howard *et al.*, 2001).
- Uneven growth brings about distortion and stunting of nuts resulting in reduction of copra yield. In extreme cases, the nuts are malformed with cracks and hardened husk (Howard *et al*. 2001; Moore and Howard, 1996)
- Infestation by coconut mite can cause extensive premature fruit drop (Doreste, 1968; Nair, 2002; Wickramananda *et al*. 2007), significant reduction in coconut fiber length and tensile strength (Naseema Beevi *et al*. 2003), as well as reduction in husk availability for the coir industry (Wickramananda *et al*. 2007).

Change in the biochemical composition of mite infested coconut buttons:

- Amount of reducing sugar in coconut water and kernel was found more in healthy nuts (nuts without any damage).
- Per cent reductions in oil content do not vary in infested and healthy nuts.
- Peroxidase value increases in infested nuts which indicate that such nuts may quickly become rancid.
- The amount of free fatty acid released from the oil increased which is an indicator of rancidity.
- Reducing sugars and the acidity content were very low in the highly damaged nuts.
- Reduction in both quality and quantity of coir.

MANAGEMENT

Coconut mite is one of the most troublesome pests to control attributable to its shrouded territory. Chemical control has not been seen as a good long term control strategy due to residue problems in coconuts, hazards to natural enemies, workers and the environment and the potential development of resistant strains of mite. Accentuation is presently being given to other potential choices like botanicals, organic control, due to its qualities like eco-benevolence and safety, is one of the alternatives for the sustainable management of coconut mite.

➢ Cultural Control: Collect and destroy all the fallen buttons of the affected palm. Grow intercrop (sun hemp, four crops/year) and shelter belt with casuarinas all round the coconut garden to check further entry. Providing adequate irrigation. Apply urea 1.3 kg, super phosphate 2.0 kg and muriate of potash 3.5 kg/palm/year. Increased quantity is recommended to increase the plant resistance to the mite.

- Eco-friendly agents: It is observed that application of neem oil 3%, neem oil 2% + garlic extract 2.5%, NSKE 5%, Fish oil rosin soap 40g/lit were effective in reducing the mite damage. Significant reduction of mite population and damage was also obtained after spraying with repeated application at regular interval of commercial formulations of azadirachtin 1% @ 5ml/lit of water to achieve maximum control.
- Biological control: Fungi- *Hirsutella thompsonii* var *synematosa, Verticillium lecani, Verticillium suchlasporium, Entomophtora* sp., *Beaveria* f. sp. *Paecilomyces lilacinus, Fusarium* sp., *Sporothrix fungorum.* Bacteria- *Pseudomonas fluorescence, Bacillus sp.* Mites- *Amblyseius paspalivorus, Neoseiulus paspalivorus and N. largoensis* (Phytoseiidae), *Lupotarsonemus* sp. *and Stenotarsonemus* sp. (Tarsonemidae), *Bdella distincta* and *Bdella indicate* (Bdellidae) are known to bring down the population of coconut mite marginally.
- Pathogens infecting eriophyid mites: Pathogens like *Sporothrix fungivorum, Lecanicillium* (*Verticillium) lecanii, H. thompsonii*, *H. thompsonii* var. *synematosa* are recorded to infect *Aceria guerreronis*. *Sporothrix fungorum* was first isolated from the coconut eriophyid mite. *H. thompsonii* reported to be promising result in controlling mite (Sreerama Kumar and Singh 2000; Gopal and Gupta, 2001). A bio-product named, 'Mycohit' based on *Hirsutella thompsonii* was developed by Project Directorate of Biological Control (PDBC), Bangalore, India. ABTEC Hirsutella is available in liquid form with a high spore count of 2 X 109 c.f.u/ml. It is applied by mixing 250 ml. ABTEC Hirsutella in 50 litres of water and spray on the coconut bunches at bimonthly intervals.
- Chemical control: Spot application of insecticides *viz.*, Carbosulfan 25% EC @ 5 ml/ lit., Dicofol @ 18.5 EC @ 6ml/lit., Ethion 50% EC @ 4 ml/lit., Wettable sulphur 80% WP @ 6 g/lit. were found to be effective in reducing the mite population (60%) and nut damage (55%). Root feeding / stem injection of insecticides *viz*., Carbosulfan 25% EC @ 15 ml, Fenpyrioximate 5% EC @ 10 ml with equal quantity of water recorded appreciable reduction in mite population and nut damage. A waiting period of 45 days is recommended for the harvest of the tender coconut and matured nuts after root feeding with above chemicals.

CONCLUSION

Today's agriculture, which is an essential part of our economy is confronted with the shifts in pest pressure, rise in mite pest problems, stringent environment regulations and need for profitable high quality produce. On one hand, phytophagous mites as pests of field crops and mites associated with granaries and warehouses cause heavy financial losses, other species have attained prominence as household pest and causative agents of allergic reactions in human beings and other mammals. Many parasitic forms act as vectors of disease causing organism. The eriophyid mites are gaining importance in recent years due to non-rational usage of pesticides; change in the cropping pattern and also due to climate change.

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A biogenetic approach for future crop production

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ABSTRACT

Human population is expected to grow to almost 1.7 billion by 2050 in India, increasingfood demand in the immediate future. Although, we have many high yielding crop varieties, acceleration in yield and productivity is requiredto meet out the demand of the future. However,Indian agriculture is continuously facing challenges due to various biotic and abiotic stresses including pests, diseases and soil salinity, etc.over time.Recently, farmers experienced significant crop losses due to COVID-19 pandemic and desert locust attack.In this scenario, deployment of modernscientific technologiescould offer new oppourtunitiestoaccelerate yield potentialthrough the development of genetically superior crop varieties that can cope up with the adverse environmental conditions.In this article, we discussed successstories ofcrop varieties developed through conventional plant breedingmethods and explained genetictechniques that helpto accelerate the breeding precesses in generating high yielding cultivars in the near future.

Keywords: Breeding, Biotechnology, Crops, Food production.

POPULATION GROWTH AND FOOD PRODUCTION

The global human population has been increasing rapidly since the mid-19th century. It was recorded about 6 billion at the end of 19th century (Van Bavel, 2013). Currently, it is standing at around 7.8 billion as of2020.Eventhough, the rise in population brings numerous challenges, especially, the need for more food is the main concern inseveral countries.Among them, India is the second most populous country that possess about one fifth of the world population. The current population of India is around 1.39 billion.

It is predicted that the human populationin India will continue to growand it will increase up to 1.7 billion by 2050AD.It implies a great demand for food productionin the immediate future. In order to feed an additional 310 million mouths, food production needs to grow in a rapid manner. The food production must rise from 252million tonnes to 333million tonnes by 2050AD.It has placed a pressure to develop high yielding varieites with beneficialquality traits for the future generation.

CURRENT PRODUCTION CHALLENGES

Nevertheless, Indian agriculture is continuously facing challenges due to various biotic and abiotic stresses such aspests, diseases andsoil salinity. Besides, food production has been affected by many natural calamities and disasters, since historic times.There are reports stating the impact of drought, flood, and cycloneswhich has occurred in the past.The production of cereals, pulses, and oilseed crops were reduced due to the occurrence of severe drought in Rajasthan (1978-79), Maharashtra(1970-73), and Ganges basin(2009). Specifically, drought in Rajasthan decreased the cereal production significantly from 14.2 million tonnes to 12.6 million tonnes during 1978-79.Other importantnatural calamities includescyclone (1964) in Tamil Nadu and flood (2015)in Gujarat that suppressed the yield of food cropsincluding rice and wheat respectively.

Moreover, there is a big challenge and pandemic situation in front of us that is due toCOVID -19 which has resulted in great loss of lives and also created an economic crisis. It affected the production of rabi crops like wheat and gram,etc. when they are at their harvest stage. Duing the lockdown period, the cost of harvesting becamehigh due to the lack of farmworkers and harvest machineries. Many harvested produce did not reach the markets properly and the farmers did not get the income.As a result, 55% farmers stored their harvested produce. Still, many farmers could not go for the storage option, because of the high cost associated with them.Further, the mobility of vegetables and fruits got stuck up due to lack of transport facilities. The supply chain was broken, the demand raised and there was aprice hikein many commodities during the crisis time. For instance the price of pulsesincluding black gram, and of pigeon pea had gone up during April-May. Particularly, the price of black gram was Rs120 per kg in March 2020 and it has gone up to Rs145 per kg during April –May 2020.

Besides, there was a locust attack in India during May- June 2020. The desert locust invadedmany states including Rajasthan, Gujarat, Punjab, Haryana and Madhya Pradesh and damaged crops such as sugarcane, cotton, summer pulses. Since 1993, India has not faced a locust attack this much huge. In Rajasthan, it has made a loss up to Rs 1000 crore. Already farmers got poor income due to COVID-19 pandemic, and the attack of desert locust had further affected their livelihood very much.

CROP VARIETIES DEVELOPED THROUGH CONVENTIONAL PLANT BREEDING

In order to develop suitablevarieites, the conventional plant breeding method usually involves crossing between two different parental lines with desirable traits. Historically, the semidwarf wheat and rice varieties which were developedthrough conventional plant breeding facilitated to double the grain yields in 40 years, from 1960 to 2000, contributed the green revolution (Newman, 1997).Sincegreen revolution, food production increasedsteadily in many parts of India and facilitated to steer the nation during the difficult times when natural disasters and calamities occurred. The main features of green revolution technology included introduction of high yielding varieties; increased application of fertilizers, pesticides, and weedicides to minimize crop losses; use of modern farm machinery; adaptation of multiple cropping systems (sequential growing of two or more crops in the same land in the same year) and deployment of suitable irrigation methods such as drip or sprinkler and expansion of existing cultivable areas.Infact, the crop varieties when they are in conjunction with fertilzers and heavy irrigation they doubled or sometimes tripled the crop yields (Newman, 1997).

At present, the National Agricultural Research System (NARS) possessing 101 Indian Council of Agricultural Research (ICAR) institutes and 71 agricultural universities develop and release various crop varieties and hybrids, for the various agro-climatic zones of India over time. For example, the recent Indian Agricultural Research Institute (IARI) released wheat variety HD-3226 (2015, in Punjab and Haryana - resistant to rust and loose smut) gives an average yield of 57.5 quintals per hectare. Likewise, other varieties released by IARI are HD-3086 (2013- Punjab and Haryana) and HD-2967 (2011 in Punjab),etc.The Central Rice Research Institute (CRRI), based in Cuttack, Odisha developed and released severaldroughttolerant rice varieties namely,Vandana, Anjali, Sadabahar, and Virendrain Jharkhand,Odisha, and Chhattisgarh. These varieties possess longer roots to draw moisture from deeper layers of the soil and also increase the yield to 3.8 tonnes per hectare under such situations. The rice variety SahbhagiDhan (2010) released by International Rice Research Institute (IRRI)based in Phillippinesis also drought tolerant and gives average yield advantage of 0.8 to 1.2 tonnes per ha over drought susceptible ones under drought conditionsin Jharkhand, Odisha.

CROP IMPROVEMENT THROUGH BIOTECHNOLOGY

However, the convential breeding require more time to develop new variety. Modern biotechnological approachesincluding DNA fingerprinting, genetic mapping, Quantitative Trait Loci (QTL) approach, genome editing, and tissue culture could help to speed up the efficiency of the breeding programme in a sustainable way (Ronald, 2014).

DNA fingerprinting is a technique, where the DNA sample of a crop is run on an agarose gel electrophoresis and the crop is identified by matching the DNA sequence. Genetic mapping is done by using molecular markers like Restricted Fragment Length Polymorphism (RFLP), Simple Sequence Length Polymorphism (SSLP) to identify certain genes controlling trait of interest, for example, rust resistance in wheat, early flowering in rice and protein content in black gram.QTL approach is a stasitical analysis that help to identify molecular marker(s) associated with which trait in the genetic map.There have been reports of QTL that may play major role in migitating the negative effects of abiotic stress in crops (Tuberosa and Salvi, 2004).

During recent years, genome sequencing of many crops including rice, wheat and maize, etc.have been completed and hence, it is easy to develop molecular markers for specific traits in a short period of time. Genome sequencing involves sequencing the whole genome of a crop that is gene sequence of all the cell organelles such as chloroplast and mitochondria and matching the sequence of the desired crop to sort out the crop (example Rice has about 400 to 430Mb). Moreover, genomic locus can be targeted and directed for evolution using the CRISPR technique. It is a powerful genome-editing tool that can be used to study different molecular pathways thus enhancing the crops to grow under abiotic stress conditions. Likewise, RNAi(interference) technology has immense potential in crop improvement as it can alter the gene expression of desired plant traits thus helps in combating the biotic and abiotic stress in plants. For example, in rice *OsANN1* gene modulates the antioxidant accumulation under abiotic stress and by overexpressing the gene in rice showed enhanced growth under abiotic stress condition (Qiao et al., 2015).

Tissue culture methods such as soma-clonal variation, embryo culture and meristem culture contributed much for the development of new crop varieties especially which are endangered and those are on the verge of extinction. Micropropagation involvesmass multiplication of plants for quick bulking of new varieties and resurgence of old varieties. Growing plantlets in tissue culture lab in a large scale and thereby make it adaptable to the environment in a gradual manner through several steps, finally, it is transferred to the field called hardening. For example G9(Grand Naine) a banana variety produced by this method is a high yielding variety (Manju*et al.,* 2012)and the fruits are delicious and don't get damage easily. In china an endangered ornamental tree, *Magnolia sirindhorniae* is propagated by micropropagation, recently (Cui *et al.,* 2019). Likewise, anther culture is practiced to obtain haploid plants of different chromosome numbers and eventually making them ready for breeding. China had produced varieties of rice (Huayu 15) and wheat (Florin) through anther culture method (Khush and Virmani, 1996). The Huayu rice variety can yield upto 8-11 tonnes per ha.By employing anther culture, doubled haploids are created when the haploid spores undergo chromosome doubling (naturally or by colchicine treatment) and later forms a diploid plant that could be used to develop a homozygous line. They are widely used to produce homozygous lines from heterozygous parents in a short period of time (Germana, 2011).

CONCLUSION

Agriculture is the backbone of the Indian economy but still, we are not self sufficient in our production. Natural calamities like floods, drought and cyclones and manmade disturbances such as water pollution by chemical industries, land degradation problems, disease infestations by new pathogens andnew invasion of pests would be a heavy block for crop production. After green revolution, excessive chemicals in the forms of fertilizers, pesticides and fungicides are used in agriculture. These chemicals got ultimately accumulated in humans or other organisms which is called as biological magnification. Here organic farming comes to play a crucial remedy role in mitigating this problem of chemical usage. Organically developing varieties with the usage of molecular markers are worth and will get a good outcome. Though we do organic farming, we need to do a lot of research and experiments, field-level trails,etc.to develop varieties with the integration of organic farming methods. Besides, tissue culture offers good scope for mass multiplication of disease free crop varieties in a short period of time.

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COVID- 19: Threat on Indian Food Sector

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The COVID- 19 pandemics have struck India at its peak level for the past few months. The country with its people is experiencing a standstill like never before and has coolly hit the FMCG sector, particularly on the Indian Food Industry. The majority of the essential commodities are highly perishable such as milk, fruits, and vegetables, fish, meat, and poultry. These commodities have to be fresh and safe from disease-causing pathogens and microbes from farm to fork. Any fault or disruption at any stage of processing and distribution seriously affects the food product. Despite all these dark hours, the happy news for the food processing sectors is that the novel corona virus does not get transmitted through food products as per up-to-date research and studies.

THE FOOD PROCESSING SECTOR OF INDIA:

From our childhood onwards we have heard that India is an agricultural country. Agriculture and allied activities are the main sources of livelihood for more than 80% population of rural India. It employs approximately 52% of labor. Its contribution to the Gross Domestic Product (GDP) is between 14 to 15%. The scope of India in Food Processing is almost double i.e to about 25 % in the next five years, compared to the present situation of 12 %. About 80% of the food is processed in developed countries. These statistics clearly show the scope of India in the Food Processing sector and the gap it has to fill to remain at par with developed countries. Even though India stands first in the production of most of the agricultural commodities, the value addition done is minimum. For the Indian economy, this increase in growth is crucial, since a large population is dependent on agricultural and food processing sectors.

MAJOR CHALLENGES FACED BY THE FOOD PROCESSING SECTOR

1. Due to the COVID-19 pandemic, the closed borders, markets, wholesale and retail shops and long waiting hours to clear the traffic is a great challenge for the food industry. The logistics sector also faces bottleneck by not being able to transport the commodities from the production site to the consumers' plate. This will lead to the raw materials and finished goods getting piled up, leading to low inventory and stock-outs. The closure of shops and markets will hinder the availability of

high-value products like fruits and vegetables, fish and meat, etc. which leads to the hard work of producers to go in vain.

2. Workers' safety: Even though the food manufactured is attained safely, the major challenge in industries is to ensure the safety of its workers. Research has shown that COVID spreads through individuals at a very high rate through their breath and speaking if the adequate distance is not maintained and PPE's are not worn. These droplets can spread through the air as aerosols and get settled on surfaces where the virus can last for more hours. Workers have to wear face masks, gloves and should maintain a 6 feet distance from each other. In addition to maintaining 6 feet distance, proper hand washing facilities, hand dryers, and sanitizers have to be maintained at appropriate points. Hand washing has to be strictly followed to the 20 secs rule by scrubbing inside and outside the palms, fingers, and in between fingers to flush off the virus in case if you have touched any object that has been contaminated. In case if the employee feels sick or shows symptoms, immediately inform your superiors. Adequate training has to be given to the workers at regular intervals.
3. Most of the new and smaller entrepreneurs have begun their food processing sector through loans and have to fill the interest and also the investments of shareholders. With the minimum movement of products among the consumers and the huge capital cost, they find an imbalance between the input cost and the return cost. Many food processing sectors work on seasonal availability on the raw material. Concessions have to be given for such industries mainly in power tariff, where they have to pay the bill even if the industry was not working. In addition to this, most of the food processing sectors run on the support of infrastructures like cold stores and warehouses which are highly capital intensive. The cost of maintaining them is very high in this period of low income.
4. Most of the challenges faced by the Food and Agricultural Processing sectors can be tackled if there is hand-in-hand coordination between the Government, Research scientists, Entrepreneurs, and employers. The Government has taken utmost care on the availability of essentials to the majority of its population through its timely action. FSSAI has decided to give additional time to Food Business Operators for renewal of licenses and registrations and has also decided the mandatory submission of annual returns for the Financial year 2020 and a half-yearly returns by licensed Food Businesses, which are highly appreciable as the country is grappled with Covid-19. Most of the food processing companies have adapted to the new changes in their production strategy.

Agronomic Zinc Bio-fortification of Food Crops for Mitigating Malnutrition

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Zinc is a critical micronutrient required for structural and functional integrity of biological membranes and for detoxification of highly aggressive free radicals. Any decrease in Zn concentration of human body will, therefore, result in a number of problems like immune dysfunctions, high susceptibility to infectious diseases, retardation of mental development, adverse pregnancy outcomes, abnormal neurobehavioral development, and stunted growth of children. Zinc (Zn) deficiency is a growing public health and socio-economic issue, particularly in the developing countries. Zinc deficiency has been identified among top priority global issues to be addressed to achieve a rapid and significant return for humanity and global stability. One of the critical physiological roles of Zn in biological systems is its role in protein synthesis and metabolism. It has been estimated that nearly 2800 human proteins are capable of binding Zn which corresponds to 10 % of human proteome. Moreover, it is reported that deficiency of zinc micronutrient is next to vitamin A being responsible for the mortality of children below the age of 5 years globally (Fig. 1). At the FAO/WHO Second International Conference on Nutrition held on 19th –21st November 2014, it was highlighted again that micronutrient deficiencies cause diverse health complications and remain highly prevalent worldwide, affecting over two billion people, with children and women at particular risk. Micronutrient malnutrition not only impairs people's health, well-being and work performance, but also poses a serious economic burden, especially on poorer nations, as shown for Zn deficiency.

ZINC DEFICIENCY IN SOILS AND FOOD CROPS

Zinc has been reported to be deficient in 30 % of the agricultural soils worldwide and about 50 % of cereal-cultivated soils have low chemical solubility of Zn to plant roots. Contribution of staple cereals to daily calorie intake reaches up to 75 % in rural areas of many developing countries, such as in Central Asia and Middle-East in case of wheat and in South-East Asia in case of rice.

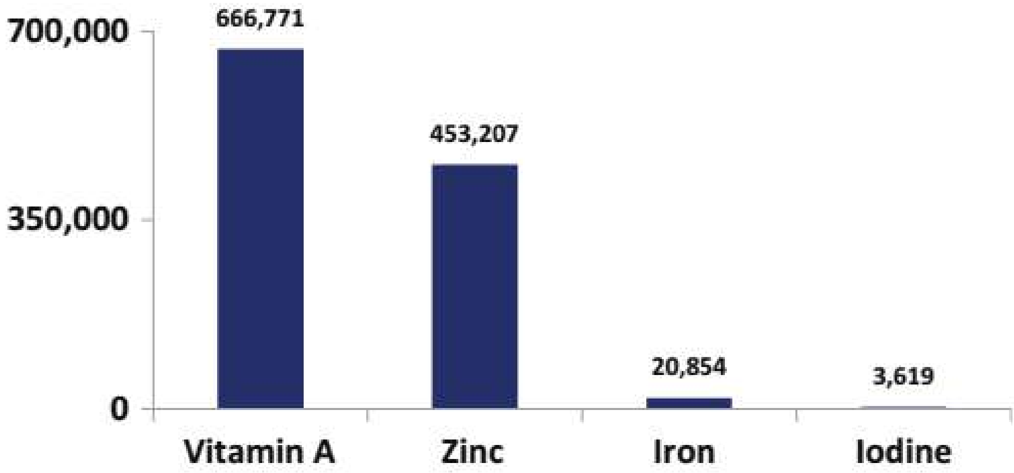

Figure-1: Global mortality of the children under 5 years of age in 2004

Rice and wheat are known to be very low in grain Zn concentrations and rich in compounds inhibiting Zn bioavailability in diet such as phytate. In addition, wheat and rice are generally more prone to soil Zn deficiency leading to a substantial reduction in grain yield and nutritional quality. So, Sustainable solutions to malnutrition will only be found by closely linking agriculture to nutrition and health and by formulating interlinked policies.

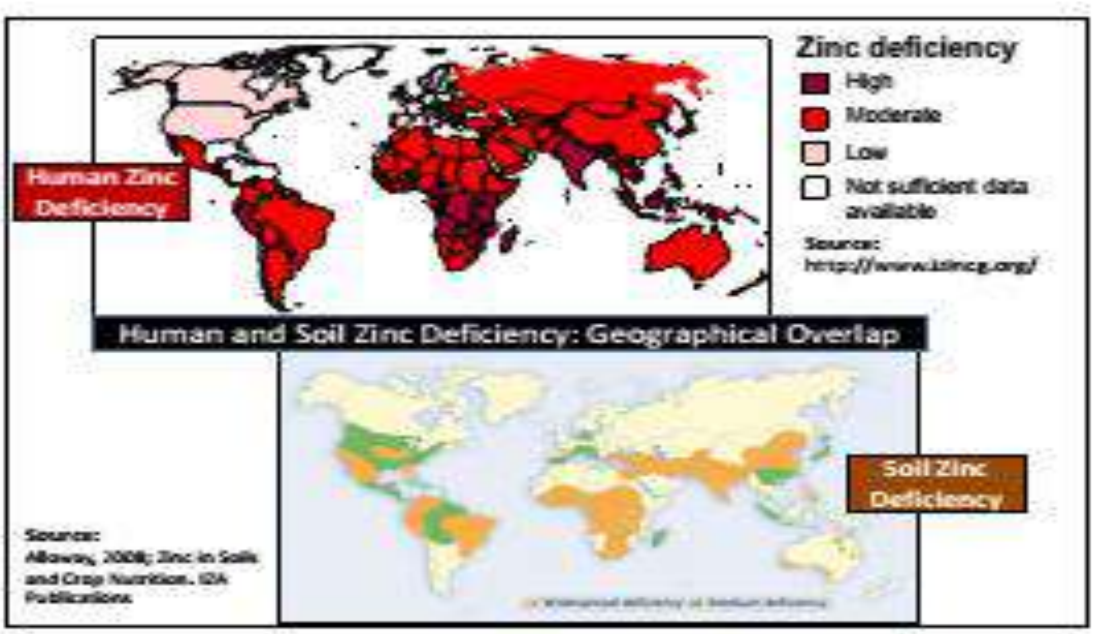

Figure-2: Geographic overlap of Zinc deficiency in Human and Soil.

AGRONOMIC BIO-FORTIFICATION

There are two options to enrich cereal grains with micronutrient especially zinc through genetic bio-fortification (development of the cereal varieties rich in micronutrients) or through agronomic bio-fortification (using fertilizers in the crops).Agronomic bio-fortification of food crops is a strategy, along with breeding/genetic engineering, for increasing micronutrient concentrations to reduce dietary deficiencies. Today, increasing micronutrient concentrations of stable food crops, especially in cereal grains, represents an important humanitarian challenge and a high-priority research area. Soil and foliar application of micronutrient fertilizer can be used for several different mineral micronutrients to varying effectiveness. Agronomic bio-fortification, especially in the case of foliar application, is highly effective for zinc and selenium, while also effective for iodine and cobalt. As an effective strategy for reducing micronutrient deficiency, zinc provides one of the best and quickest avenues for agronomic bio-fortification, particularly within cereal crops.

As per the literature available, it has been reported that foliar or combined soil + foliar application of zinc fertilizers under field conditions is highly effective in increasing grain, especially in wheat. Zinc-enriched grains are also of great importance for crop productivity resulting in better seedling vigour, denser stands, and higher stress tolerance in potentially zinc-deficient soils. Agronomic bio-fortification is essential for keeping sufficient amounts of available zinc in soil solution (by soil zinc applications) and in leaf tissue (by foliar zinc applications), which greatly contributes to the maintenance of adequate root zinc uptake. It also assists with transport of zinc from leaf tissue to the seeds during their reproductive growth stage. This approach is also required for ensuring and maximizing the success of bio-fortified food crops that are bred with higher levels of zinc. Increasing grain zinc concentrations through foliar zinc applications is similar to increasing zinc concentrations in other parts of the grain such as the endosperm, which is the most commonly eaten part of wheat grain. Since phytate (an anti-nutrient that inhibits zinc bioavailability in humans) in the wheat grain endosperm is very low, or not detectable, the increases in zinc concentration in the endosperm (up to 3-fold) by foliar zinc spraying is important for human nutrition, as it could result in higher zinc bioavailability.

ADDITIONAL REPORTED RESULTS FROM THE FOLIAR ZINC SPRAY INCLUDE:

- Among wheat, rice, and maize, wheat has been found to be the most promising cereal crop for increasing zinc in grains through foliar zinc fertilization.
- Foliar zinc fertilizers can be sprayed on leaves together with fungicides/insecticides. When tested in different countries, there was no adverse effect observed of those pesticides on leaf zinc penetration and seed/grain zinc deposition.
- Increasing nitrogen fertilization of plants very positively affected shoot translocation and grain deposition of foliarly applied zinc.
- Among the zinc forms tested for foliar Zn application (ZnO, $ZnCl_2$, Zn EDTA, nano-sized ZnO particles, and $ZnSO_4$), $ZnCl_2$ and $ZnSO_4$ gave the best result while ZnO and nano-sized ZnO particles were less effective in increasing grain zinc.

- Foliar spray solution pH and use of some adjuvants markedly affect the agronomic effectiveness of foliar zinc fertilizers. Reducing pH from 8.3 to 5 increased grain zinc concentration up to 60–70%.

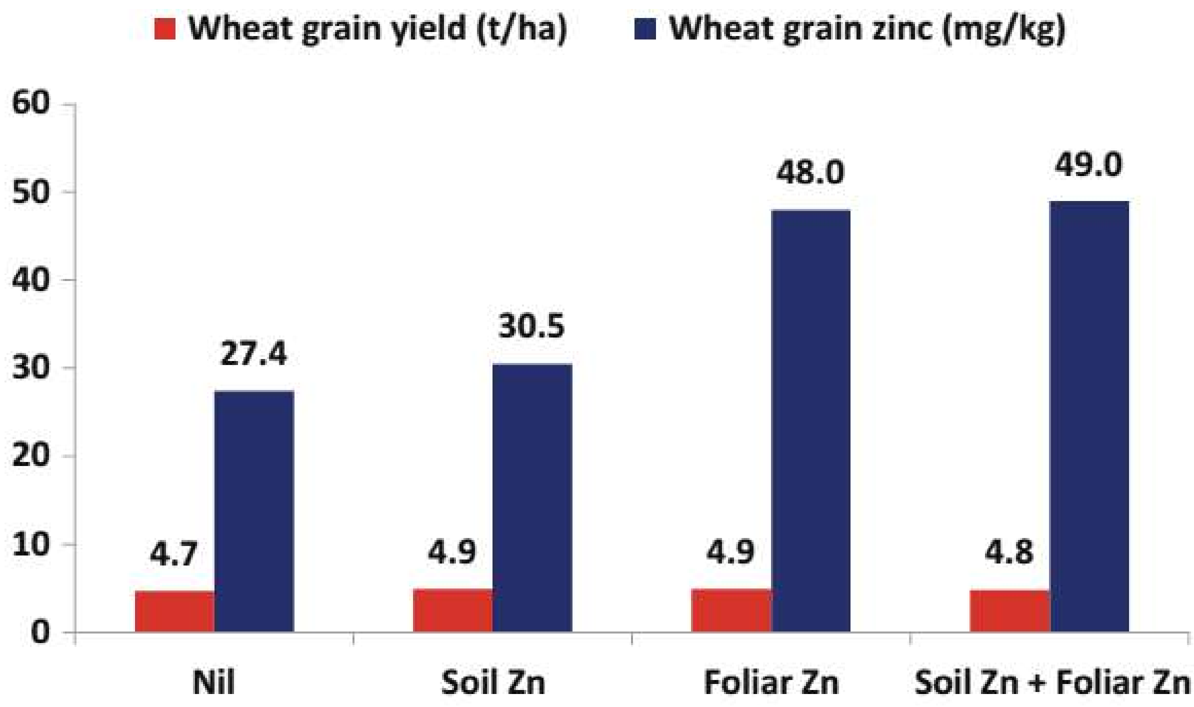

Figure-3: Wheat grain yield and grain zinc content as influenced by zinc fertilization in seven countries (Ram *et al*. 2016)

Thus, it is important to motivate and encourage farmers to spray Zn fertilizer on staple food crops for improving grain Zn concentration. However, if there is no yield advantage and no premium price of Zn-enriched grains, the farmers will not be motivated to adopt foliar spray of Zn fertilizer just for enriching the grains with Zn, as this practice involves extra investment. It is known that the Zn enriched seeds germinate better and show better crop stand and seedling vigour. In order to overcome this extra investment involving in foliar spray of Zn fertilizer, foliar Zn fertilizers can be applied in mixtures with other pesticides commonly used to controlled insect, pest and diseases. The feasibility of foliar application of zinc sulphate (ZnSO4.7H2O) to wheat, rice and common bean in combination with commonly used five fungicides and nine insecticides under field conditions at the 31 sites-years of seven countries, i.e. China, India, Pakistan, Thailand, Turkey, Brazil and Zambia has been recently tested and satisfactory results have been achieved. Further, in our state (Jammu and Kashmir) where large area is under horticultural crops and fungicides/insecticides are usually sprayed more than 10 times by growers, foliar application of micronutrients especially Zn in combination with commonly used fungicides/insecticides is required to be investigated and promoted among the farmers.