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# Editorial Board

# INDEX

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# BLACK WATER - MINERAL ALKALINE WATER

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**Summary**
Black alkaline water is enriched with many essential minerals and has a high alkaline pH of above 8. Multiple health benefits. It keeps body hydrated for a longer period of time, draws out toxins from body, helps in boosting metabolism and immunity and has anti-ageing properties that filter out free radicals.

**Introduction**
Water is the elixir of life and it constitutes about 70% of the human body. It is involved in crucial functions of the body like eliminating toxins, maintaining blood pressure, lubricating joints, and other biochemical functions.

**What is Black Water: Natural mineral alkaline water**
Black water or alkaline black water contains minerals such as magnesium, calcium, sodium, and potassium. Alkaline water pH is elevated and ranges between 8 and 9. Studies have been conducted to understand the benefits of drinking black water. Alkaline water has been effective in treating chronic diarrhoea, digestive problems like hyper acidity, indigestion, and abnormal intestinal fermentation, bone and heart health, and diabetes. Black water is the first seller of black alkaline water in India. This alkaline drink has a pH of 8 and above, and is infused with several essential minerals, and has no added sugars or caffeine.

**What are the Benefits of Black Water?**
- Alkaline black water can reduce blood viscosity following exercise-induced dehydration.
- Black water prevents aging and increases life span.
- Drinking alkaline water can be beneficial for people with diabetes by reducing HbA1c and blood glucose levels.
- Prevention of gastric acid secretion, gall bladder emptying, and removing toxins from the body have also been reported with alkaline water intake.
- Consuming alkaline water has been revealed to be heart healthy as it may be linked with reduced risk for cardiovascular disease (CVD) and coronary heart disease (CHD).
- Black water may be beneficial to bone health.
- Better sleep after consuming alkaline water may help in improving endurance recovery, prevent fatigue, and improve sports performance.

**Why black alkaline water is costly?**
Black water Priced at ₹3,000-4,000/ litre, black water is 200 per cent costlier than regular water because it has high pH and many health benefits. Despite this, it's loved by many celebrities. Known

as alkaline water, the minerals used to enrich the beverage give it a natural black colour. Therefore it's preferred over regular water by celebrities.

**Benefits of Drinking Black Water**

Alkaline black water can reduce blood viscosity following exercise-induced dehydration. A study evaluated the effect of black alkaline or the high pH water and standard water on blood viscosity and rehydration. It was found that black water significantly reduced the blood viscosity during the recovery phase after exercise but no difference was found for re-hydration.

Black water prevents aging and increases life span. An animal study found that alkaline water helps in improving longevity by slowing down the aging factor and increasing survival functions.

Drinking alkaline water can be beneficial for people with diabetes by reducing HbA1c and blood glucose levels. Alkaline water also exhibits antioxidant properties against pancreatic beta cells thereby proving beneficial in diabetes. The antioxidants present may also portray neuro-protective effects.

Prevention of gastric acid secretion, gall bladder emptying, and removing toxins from the body have also been reported with alkaline water intake.

Black water being alkaline helps in managing acid reflux by reducing the activity of enzymes responsible for acid reflux. A study revealed that alkaline water (Evamor natural artesian water, pH 8.8) denatured human pepsin rapidly and permanently. It also exhibits effective buffering activity.

Consuming alkaline water has been revealed to be heart healthy as it may be linked with reduced risk for cardiovascular disease (CVD) and coronary heart disease (CHD). The presence of high mineral content or the total dissolved solids (TDC) in alkaline water may be beneficial in reducing the incidence of cancer and bringing down the total mortality rate.

**Conclusion**

There are a number of studies that evaluated the effect of black alkaline or high pH water compared to standard water on blood viscosity and rehydration and these show that black water helps in maintaining hydration levels in the body. It is clear that the consumption of black alkaline water promotes a healthy mind and body in the long run, which is better capable of fighting diseases and any potential virus.

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# ECONOMETRIC STUDY OF SUPPLY SIDE INTERVENTIONS BASED ON MARKETING REFORMS

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**Abstract**
It has been observed that changes in wholesale prices are not either fully or partially transmitted to consumer prices via retail price. The study undertaken indicated that the retail traders are more active and are not following the price signals coming from wholesale traders even in short run. The fall in wholesale price is partially transmitted whereas the rise in wholesale prices is more than fully transmitted to the consumers. In both situations the retail traders are earning a huge profit from trading. The results of Error Correction Model (ECM) for Gram market indicated that asymmetry do exist in marketing of Gram. This varying level of asymmetry is practically an indication of market efficiency attained in different markets of the same commodity. The value of long run adjustment λ was almost close to zero in all the markets indicating that most of the changes in wholesale markets were already transmitted to consumers in the short run and very little was left for long run adjustments. Further, the study also indicated that there exists a persistent asymmetry in price transmission from wholesale to retail trade.

**Introduction**
Policy reforms are implemented through the price channel (e.g. tariffs) and lack of integration along the marketing chain prevents reforms from reaching to the stakeholders and finally leading to inequality in the distribution of incomes. Changes in consumer prices are not related exclusively to short-run changes in farm prices but follows medium and long- run changes with a time lag and downstream changes in consumer prices show a longer time lag than upstream changes. Nkang *et al*. (2007) considered that full price transmission and spatial market integration were hallmarks of market efficiency that enabled a market system to perform its development functions; the gains of which can be enjoyed by producers, middlemen and consumers in the marketing chain. Abdulai (2002) illustrated that increases in producer prices of pork in Switzerland are passed on to retail prices faster than reductions in producer prices. Deodhar *et al.* (2007) tested the wholesale price data of the year 2003, for market integration using cointegration and error correction methodologies and concluded that prices in Delhi, the major wholesale market for apples, do not seem to influence prices in other markets. Mukim *et al*. (2009) tested the presence of wheat market integration across states in India by cointegration test and common trend method, using wholesale price data. They concluded that the markets are integrated in the long run but not in short run.
Therefore, in the present study efforts were made to analyse symmetry in price transmission from wholesale to retail market of Gram.

**Data and Methodology**
The Secondary data on monthly wholesale and retail prices of Gram for the period of 2010 to 2021 was used in the study.

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Cointegration of prices between two markets can be studied with the help of pair wise linear regression.

$$Y_{1t} = \beta_1 + \beta_2 Y_{2t} + u_t \quad \text{……(1)}$$

Where $Y_t$ = price series and $U_t$ = error term.

Henry D–Gaft Acqah (2010) tested asymmetry in price transmission based on Error Correction Model when data series are cointegrated. The Error Correction Model used by Von Cramon-Taubadel (2004) has been employed in the study, with following specification:

$$\Delta p_t^r = \alpha_0 + \beta_1 \Delta p^w - \lambda(p_{t-1}^r - \varphi p_{t-1}^w) + \varepsilon^r \quad \text{----------(2)}$$

Where $p^r$ *is* the retail price at time *t*, $p^w$ is the wholesale price at time t, Δ denotes the first difference between time periods. $\alpha_0$ is an intercept, interpreted as a linear trend, $\beta_1$ represents the price transmission effect in short run and λ is a time-invariant adjustment parameters. In order to investigate possible asymmetries in wholesale and retail prices, equation (2) may be specified as:

$$\Delta p_t^r = \alpha_0 + \beta_1(\delta^w \Delta P_t^w) + \beta_2(1-\delta^w)(\Delta p^w) - \lambda(p_{t-1}^r - \varphi p_{t-1}^w) + \varepsilon^r \text{-------(3)}$$

Where: $\delta^w$ is a dummy variable equal to one if $\Delta p^w > 0$ and zero otherwise and thus it takes into account both positive and negative changes i.e. increase or fall in wholesale price. Theoretically, these changes in wholesale price should be passed on to the consumers through retail traders. A significant difference between the two β coefficients implies asymmetry in price transmission both in upward and downward price transmission and thus indicates the extent of asymmetry.

**Market Behavior: Cointegrating Relations**

In all the markets trace statistics showed that the null hypothesis of wholesale and retail prices are not cointegrated *(r=0)* against the alternative of one or more cointegrating vectors *(r>0)* is rejected. Next, the null hypothesis of r < 1 against the alternative of two or more cointegrating vectors cannot be rejected at 5 percent significance level for all the cases. The presence of single cointegrating vector showed that there exists a long run relationship between wholesale and retail prices. Similarly eigen value statistics rejects the null hypothesis of equal to or less than one cointegrating equation against the alternative hypothesis of one equation. The two statistical tests confirm long run relationship between two price series. Similarly, the cointegration test was also performed among wholesale markets of the same commodity spread over distant locations or in other words horizontal cointegration. The results of horizontal cointegration are as follows:-Results of Cointegration Test among Wholesale price of Gram at Bhopal, Chittoor, Delhi and S.Ganganagar markets. Trace test indicates 3 cointegrating eqn(s) at the 0.05 level and the same has been confirmed by Max-Eigen value test. The study further revealed that there has been no time lag in the flow of information among the wholesale markets. In case of Gram, the asymmetry in price transmission from wholesale to retail trade was examined for Bhopal, Chittoori, Delhi and S.Ganganagar markets. The situation of price asymmetry in these markets were observed as follows-

- Bhopal Market- Asymmetry in Gram trading in Bhopal market indicated that when wholesale price increases by Rs. one, the retail traders increases the price by Rs.1.91. Where as in case of fall of Rs. one in wholesale price the retailer decreases the price only by Rs. 0.83. In both the situations the retail trader is earning a net profit of Rs.1.08.

- Chittoor Market - A similar situation was observed in the Chittoor market. When wholesale price increases by Rs. one, the retail traders increases the price by Rs.1.85. Where as in case of fall of Rs. one in wholesale price the retailer decreases the price only by Rs. 0.67. In both the situations the retail trader is earning a net profit of Rs.1.18.
- Delhi Market- In this market Gram trading again witnesses' asymmetry in price transmission from wholesale to retail trade. If wholesale price increases by Rs. one, the retail traders increases the price by Rs.1.21. Whereas, in case of fall of Rs. one at the wholesale level the retailer decreases the price only by Rs. 0.22. In both the situations the retail trader is earning a net profit of Rs. 0.99.
- S. Ganganagar Market- This market also behaves like other three markets. When wholesale price increases by Rs. one, the retail traders increases the price by Rs.1.04. Whereas, in case of fall of Rs. one in wholesale price the retailer decreases the price only by Rs. 0.08. Thus, in both the situations the retail trader is earning a net profit of Rs.0.96

**Conclusion**

Price transmission conveys unbiased information on prices to the producers and facilitates efficient allocation of resources. The presence of cointegration vector and co integrating equation in all cases showed that there exists a long run relationship between wholesale and retail prices. The observed movement of retail price is not found to be in the same manner as in case of wholesale price in all the markets, which implied that retail price are not following the signals sent by wholesale markets in the short run however the two prices showed a tendency to converge in the long run. The results of horizontal cointegration test revealed that the important markets of the same commodity are cointegrated. The study further revealed that there has been no time lag in the flow of information among the wholesale markets.

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# BROWN TOP MILLET : THE MAGNIFICENT CROP OF OUR ANCESTORS

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**Abstract**
Millets are a diverse genus of small-seeded grasses commonly cultivated as cereal grains for human and animal nourishment worldwide. Brown top millet is an annual, warm-season crop that produces a lot of seeds. The seeds of this millet are well cultivated in a range of soils and climatic conditions. Browntop millet is native to India, where it grows abundantly in the arid plains of Karnataka and Andhra Pradesh, especially in the districts of Tumkur, Chitradurga, Chikkaballapura and Bellari. Earlier it was used for hay production, erosion prevention, wild animal food plots, summer grazing for cattle and food grain production. It can also be a healthy alternative to cereals and plays a prominent place in disease prevention due to its rich nutritional composition. Therefore, the production and consumption of this millet can be encouraged to improve food and nutritional insecurities.

**Introduction**
Extreme weather events like earthquakes, cyclones, droughts, floods, heat waves, and other conflicts kept the pressure on developing nations to take action to ensure food security. In order to satisfy dietary requirements and food preferences for an active and healthy life, diets should therefore include nutritious food (FAO, 2001).

Between the 1950s and the beginning of 1960, during the "green revolution," wheat and rice were the focus of intense modernization and crop-improvement efforts because of their high yields and potential to end world hunger. All millets were unable to be grown due to targeted treatments for wheat and rice. If not, millets would have been able to withstand the harsh conditions and produce abundant crops in dry regions with the right nutritional makeup to prevent nutritional deficiencies and retain excellent health (Yang *et al*., 2012; Padulosi *et al*., 2015).

Brown top millet is a native of South-East Asia. It is cultivated in Australia, China, Africa and the Middle East. In 1915, it was brought from India to the United States. It is mostly cultivated in the South-East of the United States for hay, pasture and game bird feed. It is well grown in the rain fed areas of Tumakuru, Chitradurga and Chikkaballapura districts of Karnataka state. Both in terms of consumption and cultivation, the crop is well-liked in this area. This millet seed is cultivated in a range of soils and environments. It is a robust crop that grows well in the dry land, just like other millets (Clayton *et al*., 2006; Oelke *et al*., 1990).

**Morphology of brown top millet**
Browntop millet is a warm-season annual plant with a height range of 1 to 3 feet. The pubescent nodes on the smooth stems allow them to stand upright or ascend from a decumbent base. The

leaves are smooth on both surfaces, 2.2 to 18 cm long, and 6 to 18 mm broad. The inflorescence is open, spreading, indeterminate, and has stalked flowers on a single axis. It has white blooms and 3–15 inflorescences. The ellipsoid, tan, seeds need around 60 days to reach maturity (Sheahan, 2014).


**Figure 1:** Brown top millet

**Cultivation of brown top millet**

In most places, brown top millet can be cultivated from the midst of April to August, though later plantings will produce lesser yields. When planted in rows, brown top millet has a seed rate of roughly 4-5 kg per acre and 11–12 kg per acre through the broadcast method. In a firm seed bed, the seed should be sown to a depth of half an inch. Browntop millet can be grown in tandem with a range of other crops or plants that are intended to support wildlife. Sunflowers, corn, sorghum, soybeans and peas are the species that are frequently interplanted with browntop (Bhat *et al*., 2018).

**Brown top millet for food and nutritional security**

Millets are extremely energy and resource-efficient crops due to their acclimatisation, structural and physiological adaptability and methods for evading pests, diseases and drought conditions. They produce a significant amount of output with the least amount of input. Indian agriculture, which depends more on monsoon and seasonal rains, might very well reintroduce the neglected crops to reclaim the upper hand over the coarse grains and refocus the state's agricultural development using the resources at hand (Ashoka and Sunitha, 2020).

Brown top millet, a minor millet that can be produced on low-fertile soils with little water is yet again being planted by farmers. The high nutritional value of brown top millet in addition to being a solution to the climate change issue may also be a solution to the malnutrition of rural poor people and their way of life. Browntop millet is a tough, heat- and drought-tolerant crop that can even grow in low and flooded locations. The crop can thrive under tamarind trees and does well even in shadowed conditions. Due to the crop's high nutritional value and adaptability to climate change, it can thrive in arid environments and potentially expand globally (Ashoka and Sunitha, 2020). It

grows well at altitudes of 2,000–2,500 m, with 75–150 cm annual rainfall (Roecklein and Leung, 1987).

Brown top millets are rich in dietary fibre and nutrients. Compared to rice, wheat and jowar millet is a tiny, greenish grain that is high in fibre, iron, calcium, potassium, magnesium, zinc, phosphorus and B complex vitamins (Sarita and Ekta, 2016). It is non-allergenic, gluten-free, rich in fibre with 12.0% when compared to other millet that aids in detoxifying the body and removing waste from the intestines. Fibre also relieves gluten sensitivity and constipation. Low glycemic index foods and foods high in fibre help people lose weight and contribute to healthy heart function by lowering the bad cholesterol level in the blood (LDL) and raising the good cholesterol level in the blood (HDL) (Lawes *et al*., 2004).

**Conclusion**

Brown top millet is a millet that is underutilised and disregarded by monocrop-based agriculture. Millets are ideal crops for dry land rainfed regions where the majority of our farmers are working really hard to survive, where there is a current threat of drought and a scenario where climate change may result in water scarcity. Moreover, it has a potential to improve nutritional security. Thus, it is necessary to investigate the usefulness and potential of value-adding approaches in everyday eating.

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# COLORED GRAIN SORGHUM

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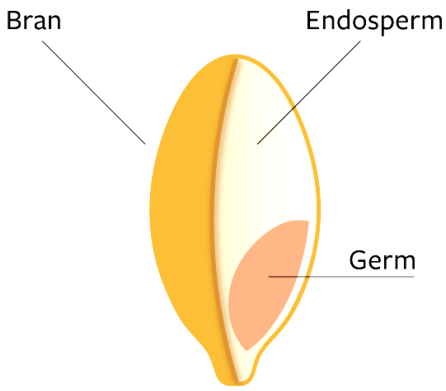
**Introduction**

"One of the vital crops required for humankind to survive is sorghum" (Harlan, 1971). The most productive, environmentally friendly, widely used, and having a lot of land under cultivation is sorghum (*Sorghum bicolor* (L.) Moench), known as the "king of millets." Both the rabi and kharif seasons are used for sorghum cultivation. While *Kharif* sorghum is well known as animal and poultry feed, Rabi is primarily used for grain and forage. One of sorghum's distinguishing qualities is the variety of grain colours. Nothing is more beautiful than viewing a field of grain of different colours in a seed production area.

The composition and feeding value of sorghum grains are comparable to those of maize, albeit their protein content varies significantly. The Southwest makes extensive use of them. For horses, sorghum grains should be steam-rolled, micronized, or coarsely ground. Sorghum has a variety of grain colours, which is one of its distinctive characteristics. Nothing is more beautiful than a field of grain of various colours in a seed production. The grain can be red, lemon-yellow, white, or black in colour. The colour of the grain seed coat alone cannot accurately describe seed colour.

**What determines seed colour?**

Sorghum is a cereal grain crop that is completely gluten-free, contains flavonoids and phenolic acids, and is richer in protein and fibre in comparison to rice flour. Due to the presence of phenolic, flavonoid, anthocyanin, and flavan-4-ol pigments in nature, sorghum land races and germplasm come in a variety of hues. The pericarp of sorghum contains this pigment. A variety of colours, including white, cream, yellow, orange, bronze, red, and brown, as well as other colour combinations of these, are available in sorghum grains. The three distinct parts of the sorghum kernel are the pericarp or bran on the exterior, the germ or embryo, and the endosperm or storage tissue. Only 6% of the entire grain, 9% of the germ, and 85% of the endosperm are made up of the pericarp. (Haikerwal and Mathienson, 1971).



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Some genotypes have a layer of cells beneath the pericarp known as the testa. Tannins, which appear to be phenolic substances found in red wine and fruits, may be present in this layer. The pericarp can be any of these hues, and the endosperm can be either white or yellow. Extremely thin (8 m) to extremely thick pericarps are both possible (160m). The colour of the endosperm, pericarp thickness, and presence or absence of the testa all influence the grain's appearance. (1981; Rooney and Miller). Two additional single genes, the "intensifier gene" and the "spreader gene," also influence grain colour. The intensifier gene affects the pericarp colour intensity. Bright red or orange-colored cultivars have the intensifier gene. When the spreader gene is present, the testa layer in hybrids produces brown grain. In the absence of the spreader gene, some high tannin cultivars with a thick white pericarp appear to be white because the testa layer is hidden. (Sema-Saldivar et al. 1995; Rooney et al. 1981).

Three factors are generally used to determine the actual colour. These include the colour and thickness of the seed coat (pericarp), the presence or absence of the testa, a layer that lies under the pericarp, and the colour and texture of the endosperm. The actual pericarp might be white, yellow, or red (colorless). The influence of the testa and endosperm on the final colour will increase with pericarp thickness. The testa will often be brown or yellow but is seldom in American sorghum. The reason for this is that the testa contains tannin, which reduces the grain's appeal to the consumer food and animal feed industries. Onyx sorghum, a black and burgundy variety with a high antioxidant content and application in specialised goods, is an exception to this rule.

**Grain Colour Preference**

The grain's colour doesn't really matter in terms of nutrients. However, certain export markets favour particular grain hues. For instance, the Chinese favour using red-colored grain to make a

popular alcoholic beverage in their nation. White grain devoid of plant colour stains is preferred by the poultry and food sectors. The two dry, leaf-like structures that surround the kernel, known as glumes, are pigmented (red or purple) and are the source of the stains. The sorghum business has created high yielding grain sorghums with white grain and tan glumes to fill this requirement. In the 2016 national grain sorghum yield challenge, where a food-grade sorghum finished third nationally with a yield of 198 bushels, the yield potential of these food-grade sorghums was clearly demonstrated.

The present food-grade sorghum hybrids have the disadvantage of being more vulnerable to grain mould. Grain mould is caused by a fungal infection that develops during blooming in warm, humid, and moist environments. If feasible, try to avoid these circumstances at flowering while planting a food-grade sorghum hybrid. Many farmers believe that lighter-colored seed won't germinate as effectively as seed that is deeper in hue. Recent research, however, has not clearly demonstrated that one grain colour is superior than another. Grain colour had no effect on warm germination or seed vigour in a University of Nebraska study on germination and seed vigour. However, under field settings, the red seed colour had a very modest advantage over the white seed. It's interesting to note that in lab studies, hybrids with purple glumes had greater germination rates and stronger seedlings. It should be observed that there was a lot of fluctuation across lines, pointing to the possibility of other causes.

**Coloured Sorghum as Feed and Fodder**

Numerous studies conducted over the past 30 years show that the nutritional value of sorghum grain is 95 to 98 percent higher than that of corn. The animal being fed will determine the purpose of consuming sorghum. Sorghum is primarily consumed by ruminant animals like cattle, sheep, and goats as a source of carbohydrates (energy). Sorghum is thought to provide energy to non-ruminants like fish, poultry, and pigs. Up to one-third of the dietary crude protein needed by poultry and up to half of the protein needed by growing pigs may be provided by sorghum-based diets. While the vitamin contents of corn and sorghum are similar, sorghum has a slightly higher concentration of the majority of minerals. (1995, Bramel-Cox *et al*). However, specific grain colours are required by some export industries. For instance, just as coloured grains are preferred in the USA for making porridge and using as Biofule, the Chinese prefer using red-colored grain to make a popular alcoholic beverage in their country.

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# FEEDBACK: VERITABLE TOOL FOR AGRICULTURAL TECHNOLOGY DEVELOPMENT AND IMPROVEMENT

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**Summary**
The utilization of passé technologies and methods, among others, predisposes the agricultural sector in developing countries to underdevelopment. In the agricultural technology and improvement space, for research to be able to develop or improve on an existing technology, it must fully comprehend the problems of the end users. Feedback helps research understand how users of technology are reacting to all the aspects of a technology/product/services. It enhances informed decisions at development and or improvement of agricultural technologies. There are two major feedback tools often used in rural sociology and the sciences; technology-based feedback platforms and in-person feedback surveys.

**Introduction**
Feedback, sometimes referred to as review is a crucial component of technological development and improvement. Though both terms are analogous and often used interchangeably, feedback is sought for while review is unsolicited. Feedback is the information, perceptions, and inputs shared by stakeholders about their experiences with utilization of products or services; it provides insight about overall outcomes, characteristics and/or consequences of technologies disseminated to clientele not leaving out their deficiencies and fixes. It is the process of relating information from end-users back to research after having received or adopted an innovation earlier disseminated to it (Oyetoro and Akinbode, 2010).

All technologies have a gap and or become obsolete at some point. As such, for efficiency and improvement of agricultural innovations, especially agricultural technologies, organizations, be it public or private, are duty-bound to have in place effective mechanism or system for collecting, analyzing, utilizing and responding to stakeholders' reviews. The importance of feedback is heightened by the cavernous information gap existing between Research and Development (R & D), extension, and users of research results impacting negatively on overall agricultural development, especially development of agricultural technologies and practices (Omotayo, 2004). For example, organizations at the frontlines of technological development in the agricultural sector especially in the Third World have had to stick with technologies long after their values have diminished because of huge financial investments that go into R & D which may not always give a tangible result. However, locking into technologies for unnecessary long period of time will not align with the ever changing technology needed in modern agriculture.

Research by itself is not all knowing; feedback creates a relationship between research and consumers of agricultural technologies by fostering conversations around and about agricultural technologies. Feedback motivates change, as such creating avenues for feedback recognizes the

fact that change is constant, and dynamic technology models are the bedrock of rural development. Feedback could be in the form of commendation for an innovation or commendation for some component of the innovation, it could also be disapproval for an innovation or disapproval for some of its components. Commendation gives credence while criticism offers ideas to make improvement to the innovation. Furthermore, research considers negative feedback as stimulant for well thought out decisions and enhance technological development.

**Feedback Mechanism**

Feedback mechanism are the tools used to garner feedback. They allow organizations ask questions while simultaneously allowing end-users ventilate their concerns and frustrations with, and give suggestions for improvement of technologies disseminated to them for optimum efficiency. Information gathered through feedback mechanism are reported to R&D units for making improvement to existing technologies or developing new ones from the scratch. For a fact, changes made to agricultural technologies based on feedback in times past have led to significant improvement in user's satisfaction (Kimano, Mukandiwa, & Mario, 2010). In-person surveys and technology-based engagement platforms are common feedback mechanisms employed in the agricultural sector.

Feedback technology-based portals and platforms enhance stakeholders' access to make regular inputs (observation, complaints, admiration etc.). The internet has broken boundaries, and the penetration of mobile and internet services to rural areas in Nigeria witnessed an increase between 2017 and 2022 (Daily Trust, 2022); the technology presents opportunities to garner feedback from rural stakeholders. In this wise, organizations have leveraged the popularity and power of the Email and social media platforms such as Facebook, Twitter and Instagram to get feedback and review from stakeholders in shortest time possible. Other widely used technology-based engagement instruments include phone call, text messages as about half the population of Nigeria and thirty percent of ruralites in the country own a smartphone (The Punch, 2022). Arguably, phone calls and text messages are among the most flexible means of getting feedback in the agricultural milieu (Adesina, 2015).

An efficient feedback tool is the in-person- feedback survey. Like the technology-based feedback platforms, it gives insight to the experiences of users of a technology, products or services. Fundamentally, this survey is usually done orally and uses standardized interview schedules whose intent is to bring to the fore perceptions, experiences, requirements and suggestions of users of a technology, product or service towards its improvement.

**Conclusion**

Little or no consideration for feedback from end users have led to impracticable, cost ineffective and ever so often culturally discordant technologies in the agricultural sector. For development of appropriate innovations and improvement of existing technologies, organizations must embrace feedback tools that allow stakeholders to give their suggestions, opinions and views. Positive feedback gives credence to technology/product/service while negative feedback stimulates further research for improvement.

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# ANALYZING INFLUENCE OF CONSUMER PRICE INDEX ON INFLATION BY SIMPLE LINEAR REGRESSION : A CASE STUDY ON BHUTAN

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**Abstract**

Bhutan is a developing economy, predominantly agrarian. There are many indicators of effectiveness of economic policies. One such is the consumer price index (CPI). CPI is an economic indicator which is mostly used as a measure of economic activity and, indirectly, of the efficacy of the government's economic policies. The CPI gives the citizens, the government, and business houses, an indication about prices fluctuations in the economy, and can also act as a tool to monitor in order to make conversant decisions about the economy. Consumer price index (CPI), producer price index (PPI), and inflation play an important role in the economy of a nation. CPI being one of the major factors affecting inflation was studied using simple linear regression. It was seen that CPI did have an effect on inflation at 6% level of significance. Residual diagnostics were also carried out using different measures to check the appropriateness of the model for the data under consideration.

## Introduction

In economics, inflation is defined as a continuous increase in the general price level of goods and services of a country over a period of time. It is obvious, that when the general price level of goods and services increases, each unit of currency will be able to buy fewer goods and services comparatively. Inflation is one of the most important indicators for economy and markets of a country. It has large consequences on the economic development of any economy. Therefore there is need for more investigations about the factors which affect inflation. To this end, there have been different attempts to analyse and model inflation in various ways. Although there have been numerous investigations on inflation phenomenon there are still missing gap about the factors analyzing which have influence on inflation. In this paper regression analysis is applied to determine how consumer price index affects inflation.

## Data and Methodology

The study is based on time-series data of monthly PPI and inflation of Bhutan available at http://www.nsb.gov.bt. We analyse the effect of CPI on inflation using the powerful technique of regression.

A regression model is a mathematical function of articulating relationship between a dependent variable and one or more independent variables. A linear function showing the relationship between *Y* and *X* variables is usually of the form.

$$Y_i = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \ldots + \beta_p X_{pi} + \varepsilon_i \qquad \text{(I)}$$

With $E(\varepsilon_i) = 0, V(\varepsilon_i) = \sigma^2, Cov(\varepsilon_i, \varepsilon_j) = 0, 1 \leq i \leq n$

Here, $\beta_0,\ \beta_1,\ \beta_2, \ldots\ \beta_p$ are the unknown regression-coefficients that are to be estimated from the data and these coefficients are called as parameters. $\varepsilon_i$ is the error term associated with observation $Y_i$ and $\varepsilon_i$ represent the part of observation which is unexplained by the independent/explanatory variables.

Now, when there is only one independent variable to explain the variability in Y, the model reduces to

$$Y_i = \beta_0 + \beta_1 X_i + \varepsilon_i$$

$$\text{With } E(\varepsilon_i) = 0, V(\varepsilon_i) = \sigma^2, Cov(\varepsilon_i, \varepsilon_j) = 0, 1 \leq i \leq n \qquad \text{(II)}$$

Equation (II) is called the simple linear regression model which is employed to estimate the relationship between a dependent variable, *Y*, and an independent, *X*, given a set of data that includes observations for both of the variables, X and Y.

**Results and Discussion**

The monthly time-series data of CPI and Inflation of Bhutan from January, 2014 to December, 2019 were collected which is available at http://www.nsb.gov.bt.

Using any standard statistical package, the output is obtained. The output is presented below:

Table 1a. Results of the regression of Inflation on CPI

| | ***Coefficients*** | ***Standard Error*** | ***t Stat*** | ***P-value*** |
|---|---|---|---|---|
| Intercept ($\hat{\beta}_0$) | 13.12 | 5.92 | 2.22 | 0.029 |
| CPI ($\hat{\beta}_1$) | -0.124 | 0.064 | -1.94 | 0.055 |

Table 1b. ANOVA table for testing the significance of the regression model

| ***Source*** | ***df*** | ***SS*** | ***MS*** | ***F*** | ***Significance F*** |
|---|---|---|---|---|---|
| Regression | 1 | 37.16 | 37.16 | 3.75 | 0.055 |
| Residual | 70 | 691.78 | 9.87 | | |
| Total | 71 | 728.95 | | | |

After the data is fitted to the model, we go for testing of significance of the parameters. That is, testing whether the model obtained based on data is really valid or not. In other words, we are testing whether there really exist a linear relationship between the dependent and independent variables. The testing is carried out by performing test of significance of the estimated regression coefficients. For this, we assume that errors are *iid* with mean 0 and constant variance $\sigma^2$. The hypothesis is given by

$H_0 :\ \beta_1 = \beta_2 = \beta_3 = \cdots = 0$

$H_1$: Atleast one of the regression coefficients is not equal to zero

We check if the calculated F value is greater than table value of F at *p* and (*n* – *p* – 1) degrees of freedom. If so, then the null hypothesis is rejected. When the null hypothesis is rejected it implies that at least one of the independent variables is linearly related with the response variable. Then, the individual regression coefficients are tested for significance.

As because we just have a single independent variable, the hypothesis is given as

$H_0 :\ \beta_1 = 0$

$H_1: \beta_1 \neq 0$

The test statistic for this hypothesis is given by

$$t = \frac{\hat{\beta}_j}{SE(\hat{\beta}_j)}$$

The null hypothesis of no linear relationship between independent and dependent variable is rejected if absolute value of *t is* greater than tabulated value of *t* at (*n* – *p* – 1) degrees of freedom at different level of significance.

From the table 1a, we conclude that CPI affects Inflation significantly (p value =0.55) at 6 % level of significance. Further, as the value of regression coefficient is negative we can infer that Inflation depends on CPI inversely, i.e. as CPI increases Inflation decreases and vice-versa. Finally, as regression coefficient of -0.124 suggests that as CPI increases/decreases proportionally by one unit, Inflation decreases/increases proportionally by 0.124.

Now to examine the appropriateness of fitted model, we carry out several regression diagnostics. ACFs of standardized residuals and squared standardized residuals are computed. It is found that, in both situations, ACFs are not significant at 5% level of significance which proves the independency of error terms.

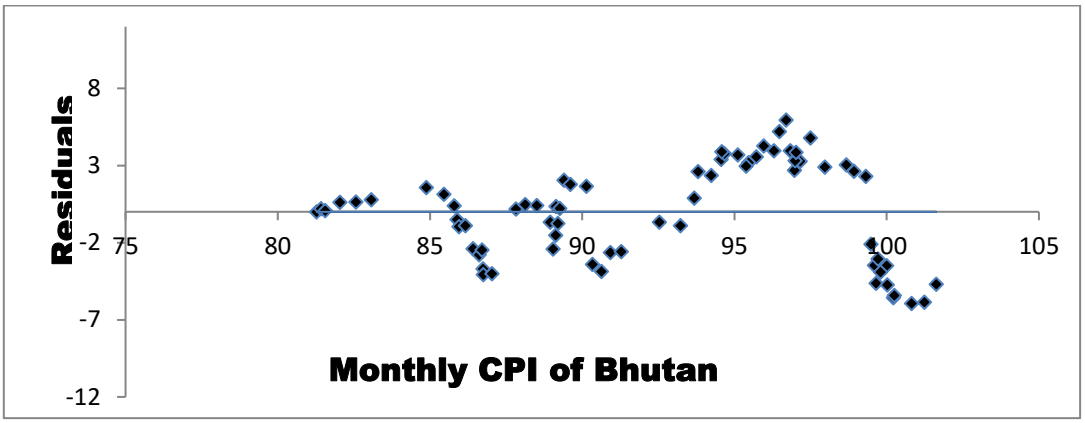


Fig. 1a. Scatter plot of residuals vs Monthly CPI

**Conclusion**

Inflation is one of the most important indicator for economy and markets of a country. It characterises a rate of increasing of general level of prices for goods and services in regard to the currency decline of purchasing power. In this paper, linear regression is applied to model Inflation keeping CPI as an independent variable. It was concluded that CPI affects inflation negatively. Further, residual diagnostics were also carried out to see the validity of the fitted model. It was concluded that the model fitted the data under consideration properly.

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# ADAPTATIONS OF *Hediste diversicolor* IN ITS HABITAT

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**Abstract**

An organism can acquire a physical characteristic or behavioral attribute that allows it to survive in a particular habitat or environment. Although those numerous marine animals may be closely related and share a variety of traits or behaviors, each one has a distinct set of adaptations that let it thrive in a particular habitat. Here, some of the selected morphological, physiological, biochemical, and genetic adaptations of the polychaete *Hediste diversicolor* are discussed.

**Keywords :** Ragworm, adaptations, habitat

## Introduction

The marine polychaete worm, *Hediste diversicolor* (O.F. Muller, 1776) commonly known as ragworm, originally named *Nereis diversicolor* inhabits burrows in the sand or mud of beaches and estuaries in intertidal zones. Due to the fluctuating environmental conditions of its habitat, it has witnessed several stress factors including pH, temperature, salinity variations, stress from other factors such as heavy metals, and so on. As organisms should tolerate and adapt to survive in their habitat, *H. diversicolor* also evolved several adaptive mechanisms. This article hereby provides a review of some of the chosen morphological, physiological, biochemical, and genetic adaptations they evolved.

## MORPHOLOGICAL AND PHYSIOLOGICAL ADAPTATIONS

### Notopodia-Gills

*Hediste diversicolor* has the highest specific branchial surface area (SBSA), according to research by [7]. *H. diversicolor* lives in hypoxic muddy sediments with little oxygen diffusion, therefore it would need to create specific adaptations for this environment. A greater notopodia surface area is a sign of better oxygen-trapping capabilities [1].

Regarding the oxygen binding capabilities at various pH levels, a lower pH (acidic) results in a drop-in affinity, whilst a higher pH results in an increase in hemoglobin's affinity for oxygen [7]. When the hydrogen ion concentration (H+) is high, resulting in decreased affinity, hemoglobin is pushed to release the oxygen molecules that are attached to it into the fluid surrounding it. Because the acidic tissues require oxygen, hemoglobin is compelled to release oxygen, reducing the amount of oxygen attached to it. This is Bohr Effect. Affinity is consequently low in an acidic media. *H. diversicolor* displays a higher oxygen affinity at the same pH. Their affinity for oxygen is a respiratory response to the oxygen tension in the ambient air [7]. In terms of ecological niches, *H. diversicolor* lives in burrows filled with mud where hypoxia is typical. Therefore, it would have evolved specific adaptations to this low oxygen level, which would account for the increased affinity.

### Detoxification mechanisms

Coastal invertebrates have physiological systems to cope with the inevitable intake of typically considerable levels of potentially hazardous metals in estuaries with high trace metal abundance

[6]. According to studies, the body of *H. diversicolor* exhibited a number of physiological detoxifying reserves with higher metal exposure. Mouneyrac et al., 2003 [5] state that in the severely metal-contaminated study area Restronguet Creek, *H. diversicolor* had detoxification stores such as Cu-carrying lysosomes in epidermal cells, extracellular granules present in the epicuticle that included S and Cu, spherocrystal cells of the gut wall seem to represent the principal detoxified store of Zn, and detoxification intracellular structures containing additional metals and metalloids in the tegument and gut epithelium.

## BIOCHEMICAL ADAPTATIONS

### Mitochondrial sulfide detoxification

*Hediste diversicolor*'s mitochondria enable them to metabolize sulfur dioxide enzymatically [2]. Sulfur dioxide is harmful mostly due to its ability to reversibly bind to cytochrome aa3, the last complex in the respiratory electron transport chain, at the heme site, hence inhibiting cytochrome-c-oxidase. Sulfide needs to be converted into a less toxic or non-toxic sulfur compound in order to deal with this dangerous chemical. In several species, including *Hediste diversicolor*, thiosulphate is favored over anaerobic end products like succinate and D-lactate. Even if the oxygen partial pressure is larger when sulfur dioxide is present, the worm will switch to anaerobic metabolism. When sulfide is not present, energy is predominantly produced aerobically under moderate hypoxia. It is quite likely that when sulfur is available, oxygen is primarily used for sulfide detoxification during hypoxia. As a result, the worms must begin their shift to anaerobiosis earlier than they would if sulfide weren't present [2].

If the electrons from the sulfide oxidation are supplied through the respiration chain to the terminal acceptor oxygen, it seems illogical that the enzyme most inhibited by sulfide at the same time is supposed to act in the detoxification of its own inhibitor. However, cytochrome-c-oxidase can only oxidize relatively small levels of sulfide. To oxidize sulfide in even larger concentrations, the animals would need sulfide oxidation processes that do not utilize cytochrome c oxidase.

### Calcium homeostasis and stable fatty acid composition

The ability of a species to withstand heat is dependent on calcium ion homeostasis, which is a characteristic of cellular signaling pathways that control total metabolic activity [3]. Maintaining calcium homeostasis is crucial for preserving cellular and metabolic processes when exposed to high temperatures. The importance of calcium ion homeostasis in thermal tolerance was revealed by experimental research in the previous study [3], which found that worms exposed to heat waves had higher amounts of several calcium-transporting ATPases. For the deeper underlying causes of the fact, more research is required.

They also maintain a steady fatty acid profile even during heat waves. Most of the fatty acids in each category, especially the palmitic, linoleic, and eicosapentaenoic acids, were in agreement with findings from earlier studies on *H. diversicolor.* These ragworms may survive in warm water without the need for lipid remodeling, as evidenced by the fact that the fatty acid profile of *H. diversicolor* has not significantly changed. This discovery is extremely relevant given the significance of the species both environmentally and economically [3].

## GENETIC ADAPTATIONS

### Hedistin - Antimicrobial peptide

An antibacterial peptide called hedistin was discovered in the coelomocytes of *Hediste diversicolor.* Nereis coelomocytes contain cytotoxic and antimicrobial properties [9]. Numerous innate host

defense mechanisms, including phagocyte actions, local and systemic bacterial death in invertebrates, and vertebrates, have been related to antimicrobial peptides. Numerous pathogens, including *Vibrio alginolyticus* and *Staphylococcus aureus*, have been demonstrated to respond well to hedistin. [9]. It was discovered that the only cells that express the gene are natural killer (NK) cells. It is the first antimicrobial peptide with Bromo tryptophan residues discovered in annelids, according to [9]. Upon bacterial stimulation, the peptide is released into the immediate environment, and the gene is constitutively expressed in NK cell-like cells. Nereis may include Bromo tryptophan as a result of an adaptation that involved the recruitment of an enzyme system that many marine organisms already employed in a particular way for defense against bacteria. The work further demonstrates that, in addition to bromotryptophan, Hedistin's fundamental structure also contains a C-terminal amidation. The presence of a Ct amide rather than a free valine residue increases the electrostatic attraction to the target membrane, such as the negatively charged bacterial membrane. This suggests that the C-terminal amidation of hedistin may aid in its bactericidal properties.

**Copper genes and proteins**

The copper stress in *H. diversicolor* led to the discovery of the copper transporters CTR1 (solute carrier family 31 protein) and ATP7A (P-Type ATPase family protein) that carry copper across the plasma membrane, into and out of the cell, respectively [4]. Additionally, it plays a part in guiding intracellular copper to the trans-Golgi network so that it can be included in freshly created cuproproteins. Because unbound Cu+ is particularly damaging to cells, Cu transport is regulated by specific chaperone proteins [4]. Nereids have orthologous proteins for this purpose, including ATOX1 (Antioxidant protein 1), which interacts with ATP736 to aid copper export or compartmentalization, and CCS (Copper Chaperone to Superoxide Dismutase35), which transfers Cu+ cofactor ions to SOD1 (Superoxide dismutase). Additionally, they have cellular thiols like those on glutathione and metallothionein/metallothionein-like proteins (MTLPs), which capture additional Cu+ and keep it out of the metabolism while aiding in the creation of detoxifying reserves [8].

Although the Cu homeostasis genes in the tolerant members of the species are upregulated, they do not show any measurable response to oxygen radicals or cellular (DNA) damage, which are the results of Cu toxicity [4]. This is consistent with the hypothesis that a detoxification mechanism, not improved cellular repair, promotes the Cu tolerance trait. There is strong evidence that the detoxifying granules contribute to invertebrate metal tolerance, and further investigation is needed to identify the genes and proteins responsible for their formation.

**Conclusion**

In a nutshell, various objectives have been acknowledged for instance the several detoxification mechanisms, stable fatty acid composition, and presence of antimicrobial peptides, copper genes, and proteins are good examples of their better adaptation to their changing environmental conditions due to stress factors from climate change and anthropogenic actions. Hence it is needed for further investigations of organisms inhabiting environments that have variable conditions for a better understanding of the underlying mechanisms.

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# MACADAMIA NUT : A FRUIT WITH SPLENDID TASTE

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Macadamia is a medium size tree indigenous to Australia, originally found in the rain forest all along the coast of north-eastern Australia. While the trees had long been known to the aborigines, who called it gyndl or jindilli and boombera. It was named macadamia nut after John Macadam, who died in a ship injury before he was able to taste the nuts. Macadamia is a member Proteaceae family. It is grown for its edible nuts. There are several species of Macadamia that exist in Australia but only two species, *Macadamia integrifolia* and *M*. *tetraphylla* and their hybrids are grown commercially. Trees of macadamia are evergreen and grow as high as 10 m. *M. integrifolia and M. tetraphylla* are cultivated but *M. integrifolia* is more common and known as smooth shelled type which has almost spherical, smooth surface kernels while *M. tetraphylla* is known as rough-shelled type and produces slightly elliptical or spindle shaped kernels with pebbled surface. The edible part, a white cream coloured kernel or embryo is enclosed in one piece very tough spherical brown seed coat or shell which is surrounded by a green, fibrous pericarp or husk. The macadamia nut resembles cashew in taste but is more oily and globular in shape.

Raw macadamia nuts are rich in carbohydrates (14%), fat (76%) and protein (8%). One hundred gram of macadamia nuts provides 740 kilocalories. It is rich in thiamine, vitamin $B_6$, manganese, iron, magnesium and phosphorus (Table1). Compared with almonds and cashews, macadamia nut has high total fat and relatively low protein. It has a high amount of monounsaturated fats (59%) including 17%, omega-7- palmitoleic acid. Macadamia nuts are used as a snack and are also used in the confectionary, baking and ice cream industries. Macadamia shells by-product may be used in skin creams, biochar and as carbon filters.

**Table 1. Nutrients in macadamia nut (edible portion per 100 g)**

| Nutrients | Quantity | Nutrients | Quantity |
|---|---|---|---|
| Protein | 7.9 g | Calcium | 85 mg |
| Fat | 75.8 g | Potassium | 368 mg |
| Carbohydrate | 13.8 g | Iron | 3.69 mg |
| Fibre | 8.6 g | Magnesium | 130 mg |
| Ascorbic Acid | 1.2 mg | Manganese | 4.1 mg |
| Niacin | 2.473 mg | Phosphorus | 188 mg |
| Riboflavin | 0.162 mg | Zinc | 1.30 mg |
| Thiamine | 1.195 mg | Moisture | 1.4 g |
| Vitamin E | 0.54 mg | Energy | 740 k calorie |

**Area and production**

The global industry is quite small, with macadamia nuts accounting for just over 1% of the total tree nut volumes produced internationally. In 2018, South Africa was estimated as the leading producer of macadamia nuts, with 54,000 tonnes out of global production of 211,000 tonnes. Macadamia is commercially produced in many countries of Southeast Asia, South America,

Australia, and North America having Mediterranean, temperate or tropical climates. Macadamia is one among the limited number of well-known tropical nuts of the world. It is delicious and nutritious nut indigenous to the eastern Australia. It is also called Australian nut or Queensland nut and is popularly grown in Australia, Hawaii, California, Florida and South Africa. Cultivation of macadamia has been attempted with good success in some isolated orchards in Kerala, Tamil Nadu, Karnataka and Orissa.

**Climate and soil**

Macadamia trees require a hot non-humid subtropical climate with high summer and low winter temperature. Macadamias prefer fertile, well-drained soils, a rainfall of 1,000–2,000 mm (40–80 in), and temperatures not falling below 10 °C, although once established, they can withstand light frosts, with an optimum temperature of 25 °C. The roots are shallow and trees can be blown down in storms. Trees have to be protected from strong winds. Trees are also susceptible to *Phytophthora* root disease. As macadamias are susceptible to decline and trunk canker disease in poorly drained soils, check the depth of well-drained soil across the orchard site. The sites having long dry season and well-drained sandy loam light soils with 5.5–7.5 pH may be preferred for the macadamia cultivation. Generally it comes up well where guava and orange thrive well.

**Varieties**

Some of the notable ones are: Kakea, Ikaika, Keaau, Keauhou, Kau, Purvis, Makai and Mauka (*M. integrifolia*); Greber, Renown, Anamour, Mammoth, Sewell and Probert 2 (*M. tetraphylla*) and Beaumont, Nelmak I and Nelmak 2 (hybrids). It is better to plant at least 2 cultivars in an orchard, although self-pollination occurs. Kakea and Keaau grow well under Bangalore conditions and good scope exists to test more number of recent standard cultivars. In South Africa, Beaumont is the most widely planted macadamia nut cultivar, followed by A4, 816, 814, Nelmak 2, 695 and 842. Cultivars Nelmak 2, 842, A4, 695 and 814 are favoured for their precocity and subsequent high yields, whereas Beaumont is favoured for its drought tolerance and 816 and A4 for its nut quality.

**Beaumont**

It is a commercial *Macadamia integrifolia* / *M. tetraphylla.* hybrid cultivar, widely planted in Australia and New Zealand; it was discovered by Dr. J. H. Beaumont. It is high in oil, but is not sweet. New leaves are reddish, and flowers are bright pink, borne on long racemes. It is one of the quickest varieties to come into bearing once planted in the garden, usually carrying a useful crop by the fourth year and improving from then on. It crops prodigiously when well pollinated. The impressive, grape-like clusters are sometimes so heavy they break the branchlets to which they are attached. In commercial orchards, it has reached 18 kg per tree by 8 years old. On the downside, the macadamias do not drop from the tree when ripe and the leaves are a bit prickly when one reaches into the interior of the tree during harvest. Its shell is easier to open than that of most commercial varieties.

**Maroochy**

A pure *M. tetraphylla* variety from Australia, cultivated for its productive crop yield, flavor and suitability for pollinating 'Beaumont'.

**Nelmac II**

A South African *M. integrifolia* / *M. tetraphylla* hybrid cultivar, has a sweet seed, which means it has to be cooked carefully so that the sugars do not caramelise. The sweet seed is usually not fully

processed, as it generally does not taste as good, but many people enjoy eating it uncooked. It has an open micropyle (hole in the shell), which may let in fungal spores. The crack-out percentage (ratio of nut meat to whole nut by weight) is high. Ten-year-old trees produce an average 22 kg (50 lb) per tree. It is a popular variety because of its pollination of 'Beaumont' and the yields are almost comparable.

**Renown**

A *M. integrifolia* / *M. tetraphylla* hybrid, this is a rather spreading tree. On the plus side, it is high yielding commercially with 17 kg (37 lb) from a 9-year-old tree and the nuts drop to the ground. However, they are thick-shelled, with not much flavor.

**Propagation**

Although macadamia nut can be propagated by seeds, the commercial production of nut is almost exclusively from grafted trees of known varieties. Seedling trees have proven to be unsatisfactory due to great variation in productivity and kernel quality. They also have longer juvenile phase and sometimes produce bitter nuts with low oil content. The grafted trees produce 3–4 times more nuts on an average, providing 15% higher kernel yield. Macadamia is propagated by wedge grafting on seedling rootstocks. The well mature husked nuts should be used for raising the rootstocks. In-situ grafting can also be practised, if more attention and care are taken.

**Rootstocks**

Most commonly used rootstock in South Africa is Hinde (H2). It is easily propagated and produces vigorous and uniform seedlings.

**Planting**

Orchard design usually favours long rows to maximise land use and machinery operation. Planting distance can vary from high density (6 x 3m) to low density (10 x 4m) depending on tree variety, soil conditions and topography. Staggered planting within rows to form equilateral triangles is favoured by some, but the main trees usually form long hedgerows. High-density crops will have a greater blossom density and as such would require a greater amount of bee hives to ensure best possible pollination (AMS, 2009).Traditional grafted macadamia trees take 24 months from seedling rootstock to grafting and field planting whereas mini-grafted trees take 10-12 months from seed to field planting. The much newer micro-grafting technique can take only 8-12 months to field planting.

**Manuring**

An annual dose of 450 : 150 : 500g of N:$P_2O_5$:$K_2O$/tree (in 2 splits) is recommended in addition to 40–50kg of farmyard manure.

**Irrigation**

The amount of water to be supplied depends on rainfall, evapo transpiration, soil type and plant vigour. The soil should be kept moist, but not wet, to a depth of at least 1m.

**Pruning**

Pruning is required to get a tree form with a single main stem and a framework of horizontal branches, starting just above ground level and from there, at spacing of 0.5 meter is recommended. In each of the 3 leaf axils of a node, 3 buds are found in a vertical row. All the 3 upper buds get activated and start growing straight when a stem is pruned. One of these is allowed to grow while

the other two are clipped off which induces the buds below them to grow in a horizontal direction. From time-to-time, weak and damaged branches, if any, are removed.

**Pollination**

**Flower biology**

Macadamia flowers are largely self-compatible and protandrous with anthers opening several days before the stigma is receptive. Initial and final nut set are positively correlated with insect visitation rates and orchard yields may be increased by inter planting varieties. Flowering occurs from July to September. Flowers arose from lateral buds on 1-year-old shoots. The ivory white flowers are produced in a long simple raceme about 17.9 cm long and are borne in groups of three or four numbering on an average 175.6 flowers per raceme. The individual flower is 15 mm long. Flowers are perfect, each having four stamens and a pistil. The stamens are attached to the sepals. The style forms a sharp loop in its mid- section just before the flower opening to get pollinated. The time of anthesis was 4:30 – 6:00 hrs. The initial fruit set is 1.71 % only. The number of days taken from flowering to initial fruit set was 52 days. Because macadamia trees flower heavily, large numbers of insects are attracted which results in higher levels of cross-pollination than would be achieved if fewer flowers were presented. Macadamia flowers are protandrous (have bisexual flowers) and are partially self-compatible. In Australia, the major pollinators in commercial macadamia plantations are from two genera of social bees: the introduced honey bee, *Apis mellifera*, and native bees of the genus Trigona. The studies done at Chettalli found that among the different pollinating insects, *Apis cerana indica* was found visiting flowers throughout the day and was the dominant one over other insects. Visit of other insects such as, *A. florea*, *A. dorsata*, *Trigona spp*. was either minimum or nil.

**Harvesting and Postharvest management**

Trees do not begin to produce commercial quantities of seeds until it is 7–10 years old, but once established, may continue bearing for over 100 years. The tree is slow to come to bearing. On an average, 7-year-old trees start bearing. However, 20-year-old ones give full yield and continue to yield for about 40–60 years. Under Bangalore conditions, flowering occurs during March, July – October and fruits are ready in October to March under Bangalore conditions. The fruits are borne in clusters and on maturity; the husk begins to dry and split, exposing the inner brownish nut. The fruits naturally drop and can be gathered by hand. Even shaking the trees or branches makes the mature fruits to fall. In some countries, harvesting is mechanized or is done by using suspended nets. In Hawaii, a yield of 80–90 kg nuts/tree after 18 years of planting has been recorded.

At ICAR-IIHR, Bangalore, we have identified one promising seedling selection MN III- 0101, aged 12 years old with 5.5 m height with East west canopy of 3.15 x 4 m and north south canopy of 4.2 x 3.85 m. The girth at base is 90 cm and girth at first branching is 45 cm. It has registered yield of 20-22 kg mature nut with an average fruit weight >12g with nut seed weight- 8g and 3g kernel weight.

Once the fruits are harvested, the husking and drying operation should begin immediately. After cracking the hard shell, raw kernels are dried to about 1.5% moisture, which can be held satisfactorily for about year. Although the kernels are edible as such, the usual practice is to consume after roasting and salting; roasted nuts can be used in chocolate-coated nut candies, bakery products and ice-creams. Alternatively, the kernels are deep fried in oil for 15 minutes at 135°C and used in various ways.

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**Pest and disease management**

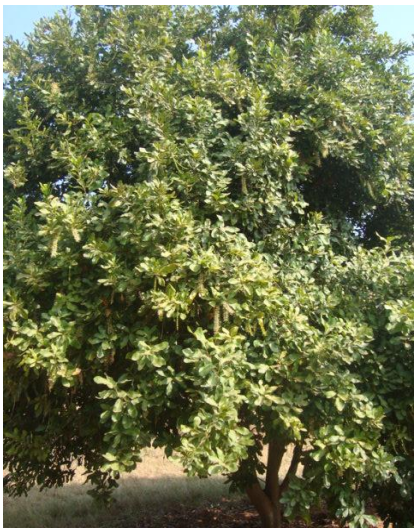
**Pests**

The major pests likely to cause problems in young trees are macadamia felted coccid, scale insects (mainly latania scale and long soft scale), macadamia twig-girdler, macadamia leaf miner, red shouldered leaf beetle (monolepta beetle), hares and kangaroos/wallabies. From planting, inspect trees regularly for these pests. Low levels of scale insects, twig-girdler and leaf miner can be tolerated without spraying and will often be effectively controlled by beneficial insects. It is only if infestations become severe, that spraying is necessary. However, felted coccid and red shouldered leaf beetle are much more dangerous and if detected, spraying is generally required immediately.

The rats are major problem in most of the orchards .The rats damage mature fruits and eat kernels.

**Diseases**

The only major disease of young trees is trunk canker. Where cankers are small, pare back the affected bark and wood with a sharp knife, and thoroughly soak trunks with a registered copper fungicide mixed with white, water-based paint. This helps to maintain contact with the fungicide and seals the wound. Where cankers are more extensive, and paring back affected bark and wood is impracticable, spray affected areas with metalaxyl and copper oxychloride. Alternatively, spray the affected trees with phosphorous acid. Repeat the treatment two to three months later to control the disease.



Grown up tree

Inflorescence

Fruiting

Mature fruits and nuts

**Fig.1. Tree, inflorescence, mature fruit and nuts of promising seedling selection, MN III- 0101**

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# BIOREMEDIATION OF AGRICULTURAL SOIL POLLUTED WITH PESTICIDE

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**Abstract**
Pesticides are chemical compounds used to eliminate pests; among them, herbicides are compounds particularly toxic to weeds, and this property is exploited to protect the crops from unwanted plants. Pesticides are used to protect and maximize the yield and quality of crops. The worldwide use of pesticides for pest control in agriculture and some industrial processes has contributed to improve the food and goods production. However, their intensive use has resulted in the release of a wide range of xenobiotic compounds to the environment, widespread among air, water, and soil. The existence of contaminated sites is an important environmental and health concern today. The main challenge is to reduce the amount of these chemicals and obtain agricultural soils suitable for growing eco-friendly crops. The microbial metabolism of indigenous microorganisms can be exploited for degradation since bioremediation is an eco-friendly, cost-effective, rather efficient method compared to the physical and chemical ones. Several biodegradation techniques are available, based on bacterial, fungal, or enzymatic degradation. This review aims to give a picture of the bioremediation of soils polluted with commercial pesticides, considering the features that characterize the main and most used ones, namely their classification and their toxicity, together with some elements of legislation into force around the world.

**Introduction**
Pesticides are important tools in agriculture as they help to minimize economic losses caused by weeds, insects, and diseases. The use of pesticides has benefitted modern society by improving the quantity and quality of the world's production while keeping the cost of that food supply reasonable. Unsurprisingly, pesticide use has become an integral part of modern agricultural systems. Because of continuous pest problems, their usage possibly cannot be discontinued in the near future (**Tejada *et al.,* 2011; Anjum *et al*., 2012**). Residues of pesticides in animal products and other food items ultimately get accumulated in human beings especially in the adipose tissue, blood, and lymphoid organs and can cause immunopathological effects which acquire immune deficiency, autoimmunity, and hypersensitivity reactions like eczema, dermatitis, and allergic respiratory diseases.

During the 19th and 20th centuries, the extracts from plants, namely pyrethrin, were used as insecticides, fungicides and herbicides. The increase in pesticide use happened with synthetic

chemistry during the 1930s. In this period, inorganic chemicals such as arsenic and sulphur compounds were applied for crop protection. The arsenic poison was fatal to insects, while the sulphur was used as a fungicide. At the beginning of the Second World War, numerous pesticides were synthesized, mainly organic chemicals, such as dichlorodiphenyltrichloroethane (DDT), aldrin, and dieldrin used as insecticides, while 2-methyl-4-chlorophenoxyacetic acid (MCPA) and 2,4-dichlorophenoxyacetic acid (2,4-D) were used as herbicides.

Long after their use, the pesticides remain in soils and sediments where they can enter the food chain directly or percolate down to the water table. Once in the groundwater, these compounds can enter drinking water wells and cause health problems. These chemicals are also subject to long-range atmospheric transport. Several strategies involving biological, physicochemical, and thermal processes have been developed to remediate contaminated sites.

The regular monitoring and control of pesticide usage in agriculture is very important because of the risk posed by pesticides on human, animal, plant health and on the environment (**Rani *et al*., 2014**).

**Bioremediation**

Bioremediation reduces pesticide contamination of agricultural soils by biodegradation processes via the metabolic activities of microorganisms. It is an efficient, cost-effective, and environment-friendly treatment.

During the bioremediation processes, the microorganisms use the pesticides as substrates in their metabolic reactions together with other nutrients, thus eliminating them from the environment. The efficiency of these processes depends on the characteristics of pesticides, such as their distribution, their bioavailability, and their persistence in soil. It is necessary to promote the availability of pesticides to microorganisms: this is negatively affected by the adhesion of pesticides to soil particles and their low water solubility. In addition, the soil characteristics and the environmental conditions, such as pH, water content, microbial diversity, and temperature, influence the bioremediation efficacy.

**Mechanism of Bioremediation**

The microorganisms involved in the degradation process are bacteria or fungi, which may generate intra- or extra-cellular enzymes. Their mechanism of degradation are described below-

**Bacterial Degradation**

In the years, several bacterial strains were identified as capable of degrading the pesticides present in the soils. Each bacterium has a specificity that makes it particularly suitable for a degradative process. The operative conditions, such as temperature, pH, water content, and types of pollutants, affect the adaptation, development, and role of a bacterial strain. As an example, chlorpyrifos, an organophosphate used as an insecticide, is hydrolysed by microorganisms, and the primary and major degradation product is 3,5,6-trichloro-2-pyridinol (TCP). TCP has greater water solubility than chlorpyrifos and causes widespread contamination in soils and aquatic environments. Few microorganisms can degrade the pesticide and its metabolite and among them the bacterium *Ochabactrum* sp. JAS2 is capable of hydrolysing both compounds. In the metabolic pathways of pesticide degradation, each bacterium can generate metabolites that may be used as a substrate by others.

**Fungal Degradation**

The agricultural soils are populated by many fungi, which can be exploited to biodegrade pesticides. This class of microorganisms includes yeast, moulds, and filamentous fungi. Fungal degradation is

promoted by its capacity to produce many enzymes involved in degradative processes. These microorganisms also can influence the soil properties, modifying soil permeability, and ion exchange capability. Fungi can be better degraders than bacteria due to their characteristics, such as specific bioactivity, growth morphology, and high resistance even at high concentrations of pollutants. A common approach is to use both fungi and bacteria to enhance degradation since fungi can transform pesticides into an easier and accessible form for bacteria.

**Enzymatic Degradation**

Enzymatic biodegradation is due to the enzymes produced during the metabolic processes of microorganisms or plants. Enzymes are biological macromolecules that can catalyse biochemical reactions involved in pesticide degradation. These molecules act in the rate of reaction by lowering the activation energy of the reaction itself. The main metabolic reactions, where they are involved, are oxidation, hydrolysis, reduction, and conjugation. Oxidation, which is the first step of the degradation of pesticides, consists of the transfer of an electron from reductants to oxidants. Oxygenase and laccase enzymes may be involved in this reaction. Hydrolysis permits the cleavage of bonds of the substrate by adding hydrogen or hydroxyl groups from water molecules. The pesticide molecules are thus divided into smaller chain compounds than the original ones. Typical enzymes involved in the hydrolysis pathways are lipases, esterase, and cellulases. Reduction permits the transformation through reductive enzymes (nitro reductase).

The conjugation reaction is carried out using existing enzymes, and it is typical of fungal biodegradation. It involves the addition of exogenous or endogenous natural compounds to facilitate the mineralization of pesticides. This process includes reactions such as alkylation, acylation, and nitrosylation.

**Conclusion**

No doubt the pesticides have caused serious impact on the soil fertility. Soils contaminated with pesticides have attracted high attention because it impacts human health and natural ecosystem. Bioremediations has a tremendous potential for remediation of the soils that are affected by pesticides. Microorganisms that are present in the soils can remove pesticides from the environment. Biopesticide enzymatic degradation of polluted environment represents most important strategy for pollutant removal and degradation of persistent chemical substances by enzymatic reactions have been found high bioremediation potential. Hence bioremediation is much promising approach to overcome the pesticide pollution that can surely solve the problem of pesticide pollution of soils. This technology has proved again and again its potential to degrade not only pesticides but also the various in organic compounds. So time is to utilize this eco-friendly technology for better and safe future.

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# MILLETS : UNDERRATED POWERHOUSE OF NUTRIENTS

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Millets offer twin advantages of addressing both production and consumption demands relevant to the country today. The millets are highly suited to poorly endowed production ambience as they are low in water footprint and therefore suited to arid regions requiring as low as 300 to 400 mm of water. Besides they are crops of short duration maturing within 60 to 90 days. Millets are resource-use efficient and respond well to good agronomic conditions. They are climate-resilient, exhibit hardiness and are highly adaptable under critical drought conditions. The millets besides being nutritively good for human consumption, are also a nutritious fodder as they are rich in iron, magnesium, copper, phosphorous zinc, calcium and potassium.

**Global Distribution and Production of Millets**

The world production of millets was 26.7 million metric tonnes from an area of 33.6 million hectare. In 2002, the world production of millets was down to 23.3 million metric tons from an area of 33.3 million hectare. Africa was the largest producer of millet in 2009 (20.6 million metric tonnes), followed by Asia (12.4 million metric tonnes) and India (10.5 million metric tonnes). Relative to wheat, rice, maize and barley, sorghum ranks fifth in importance, in terms of both production and area planted, accounting for 5% of the world cereal production.

**Global Production**

The global production of pearl millets has come down from 32.8 million tonnes in 2010 to 28.4 million tonnes during 2014. Asia and Africa are the major contributors of worlds total pearl millets production contributing more than 98% of the global production. The share of African countries in global millets production has come down from 49.22% in 2010 to 43.72% during 2014, whereas the contribution from Asian countries has increased to 52.25% from 48.72% during 2010. Sorghum (*Sorghum bicolor* (L.) Moench) is the fifth major cereal of the world after maize, paddy, wheat and barley. The world sorghum production increased significantly during 2014 to 68.9 million tonnes from 60 million tonnes in 2010, after a drastic reduction in 2011 to 57 million tonnes.

**Distribution of Millets in India**

India is the top most producers of millets followed by Nigeria for the year 2000 and 2009. In India, eight millets species (Sorghum, Pearl millet, Finger millet, Foxtail millet, Kodo millet, Proso millet, Barnyard millet and Little millet) are commonly cultivated under rain fed conditions. For instance, while pearl millet and sorghum are primary crop and allied crops respectively in the desert regions of Rajasthan, in the eastern parts of Rajasthan and Gujarat it is the opposite. Similarly, sorghum is sown as major crop in the Telangana, Andhra Pradesh, Maharashtra and parts of Central India. Likewise, Finger millet is a primary crop in Tamil Nadu and Gujarat, while the same is a minor crop in Telangana. Hence, the spatial distribution of millets


**Millet Map of India**

either as a primary crop or as allied crops largely depends on the growing habitat and the amount of rainfall the region receives. Further, the small millets are found in most of the southern and central states in India.

**International Year of Millets (2023)**

The need to promote the diversity and nutritional and ecological benefit of millets to consumers, producers, value chain actors, and decision makers is timely, and can improve food sector linkages. As such, a proposal for an International Year of Millets (2023) was brought forward by the Government of India and endorsed by Members of FAO Governing Bodies, as well as by the 75th Session of the UN General Assembly.

The International Year of Millets, therefore, stands to provide a unique opportunity to increase global production, ensure efficient processing and consumption, promote a better utilization of crop rotations, and encourage better connectivity throughout food systems to promote millets as a key component of the food basket.

The International Year will

**(i)** Elevate awareness of the contribution of millets for food security and nutrition

**(ii)** Inspire stakeholders on improving sustainable production and quality of millets

**(iii)** Draw focus for enhanced investment in research and development and extension services to achieve the other two aims.


The UNGA adopted the resolution declaring 2023 as the International Year of Millets. Co-organized by the Permanent Missions of India and of Nigeria to the United Nations, with the support of FAO.

**Health Benefits of Millets**

Millets have potential health benefits and epidemiological studies have showed that consumption of millets reduces risk of heart disease, protects from diabetes, improves digestive system, lowers the risk of cancer, detoxifies the body, increases immunity in respiratory health, increases energy levels and improves muscular and neural systems and are protective against several degenerative diseases such as metabolic syndrome and Parkinson's disease. The important nutrients present in millets include resistant starch, oligosaccharides, lipids, antioxidants such as phenolic acids, avenanthramides, flavonoids, lignans and phytosterols which are believed to be responsible for many health benefits.

**Specific health benefits of millets**

- Offer hunger satisfaction due to the presence of high dietary fiber
- Reduce risk of diabetes and cardiovascular diseases
- Reduce occurrence of hypertension
- Reduce oxidative stress as they are rich in antioxidants detoxify body.
- Reduce anaemia, liver disorder and asthma
- Prevent allergies reactions due to their hypo-allergic properties
- Fiber content in millets helps in eliminating disorders like constipation, excess gas, bloating and cramping.

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# MILLETS : THE NUTRI CEREALS

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**Abstract**

Millets are member of small-seeded grasses that are commonly cultivated as cereal crops or grains for human and animal nourishment all across the world. Sorghum and bajra are major millet crops grown globally. Millets are extremely resilient to drought and other harsh weather. Sorghum, finger millet, pearl millet, proso, foxtail, tiny, kodo, and barnyard millet are among the principal millets that make up millets. They are rich source of many nutrients and minerals and thus also known as Nutri Cereals. Government of India has taken many important initiatives to promote their production and value addition. It has also decided to celebrate IYOM, 2023 to make it peoples' movement so that the Indian millets, recipes, value added products are accepted globally.

**Introduction**

Millets are a group of cereal grains belonging to the Poaceae family, also referred to as the grass family. Millets were among the earliest plants to be cultivated. They have been a traditional source of food for hundreds of millions of people in Sub-Saharan Africa and Asia for more than 7,000 years and they are today cultivated all over the world. They offer food, fuel, fodder and nutrition security and can be grown in intercropping (or maybe under mixed cropping with oil seeds and pulses). They are rich source of nutrients like protein, carbohydrate, good quality fat, dietary fibre and many minerals. Due to their high nutritional value, millets are also referred to as **"nutri-cereals".** Despite being a staple food source for millions of people worldwide, its production is declining now. In light of this, the Indian government suggested that **2023** to be designated as the **International Year of Millets**. It was endorsed by members of FAO governing bodies and at the 75th session of the UN General Assembly (UNGA). India produces a nine commonly known millets and is the largest producer and second-largest exporter of millets in the world. Among the nine types, most popular millet variety is pearl millet, an important crop in Africa and India. Other significant crop species include finger millet, foxtail millet and proso millet. They are considered ancient grains and are consumed as food for humans, birds and animals.

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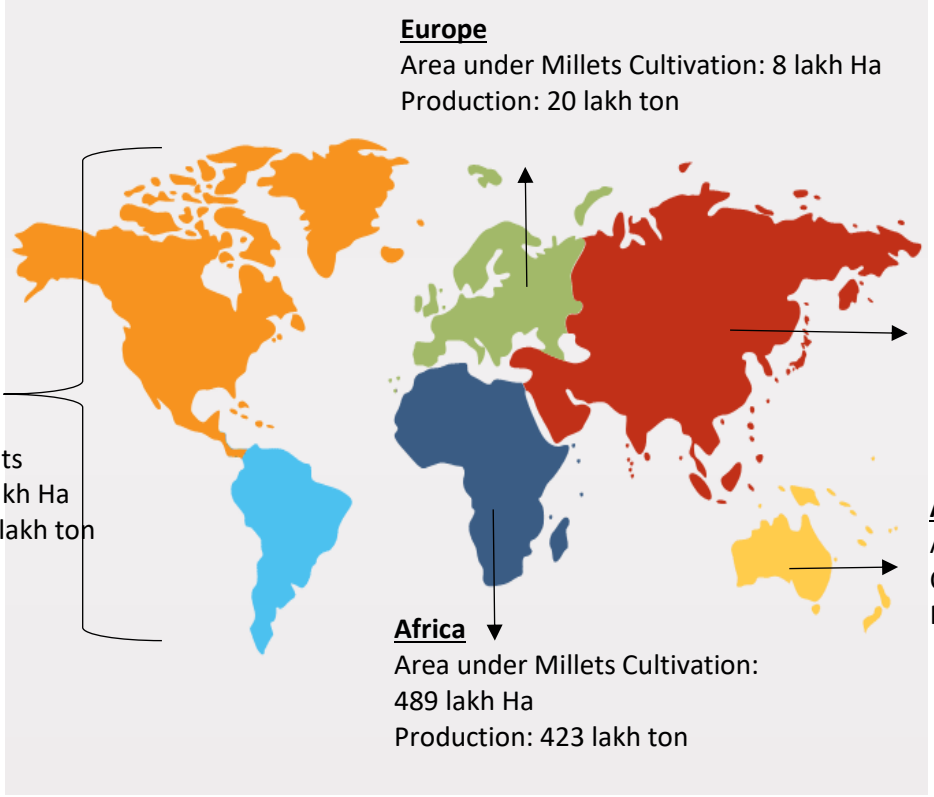
## Millets Scenario – World and India

### Global Scenario




Source: FAOSTAT 2020

Sorghum is the major millet cultivated globally constituting 65 per cent of total millets. During 2010–2020, the Sorghum area was near stable between 42.16 million hectares (m ha) to 40.98 m ha while production between 60.18 million metric tonnes (MMT) to 58.70 MMT. During the same time period, the area under other millets showed a decreasing trend from 36 m ha during 2010 to 33.02 m ha during 2020, while production decreased from 32.79 MMT in 2010 to 30.46 MMT in 2020.

### India Scenario

India is one of the leading producers of millets in the world. In India, millets are cultivated on an area of 12.45 m ha, producing 15.53 million tonnes with a yield of 1247 kg/ha. Sorghum is the fourth most important food grain in India after rice, wheat, and maize in terms of area (3.84 m ha) and production (4.31 MMT). Bajra (7.05 m ha) contributes more than 50 per cent of the country's area under millets with almost equal percentage of production. It is interesting to note that, India is the topmost producer of Barnyard (99.9%), Finger millet (53.3%), Kodo (100%), Little millet (100%) and pearl millet (44.5%), producing about 12.46 MMT from an area of 8.87 m ha.

Rajasthan has the highest area under millets cultivation (29.05%) followed by Maharashtra (20.67%), Karnataka (13.46%), Uttar Pradesh (8.06%), Madhya Pradesh (6.11%), Gujarat (3.94%) and Tamil Nadu (3.74%). The states of Gujarat and Madhya Pradesh have increased their area under millets over the recent years. However, the highest yields were recorded in Andhra Pradesh

(2626.58 kg/ha), Tamil Nadu (2153.22kg/ha), Haryana (1906.78 kg/ha), Gujarat (1762.05 kg/ha) and Madhya Pradesh (1729.70 kg/ha).

**Millets and the Nutritional Benefits**

- Millet grains are rich sources of nutrients like protein, carbohydrate, good quality fat, dietary fibre and have substantially higher amounts of minerals like calcium, potassium, iron, magnesium, manganese, zinc, and B complex vitamins, making them a preferable alternative over the cereal grains.
- Millets also contain several bioactive phytochemicals including lignans, β-glucan, inulin, sterols, resistant starch and phenolic compounds (e.g., ferulic acid, caffeic acid and quercetin). Many studies have supported the role of polyphenols in antioxidant, anti-carcinogenic, anti-inflammatory, antiviral and neuroprotective activities which in all have shown to be beneficial against diseases like cancer and cardiovascular disease, diabetes, high cholesterol, high blood pressure, metabolic syndrome and Parkinson's disease.
- The millets are also regarded to have DNA damage protection antimicrobial and activities due to their phytochemical content. The millet grain contains a very high percentage of non-starch polysaccharides and dietary fibre, both of which aid in controlling weight. Due to the slow release of glucose, millets are a fantastic option for diabetics.
- Fermentation of millets using various cultures promotes the growth of Gram-negative bacteria that makes millets an effective probiotic food in the gut.

**Comparison on Nutritional Composition of Rice and Wheat with Millets**

**Table 1: Nutritional profile: Comparison of millets and cereals for quality**

| Crop | Protein (g) | Carbohydrates (g) | Fat (g) | Fiber (g) | Minerals (g) | Calcium (g) | Phosphorus (g) |
|---|---|---|---|---|---|---|---|
| Bajra | 11.6 | 67.5 | 5.0 | 1.2 | 2.3 | 42 | 296 |
| Sorghum | 10.4 | 72.6 | 1.9 | 1.6 | 1.6 | 25 | 222 |
| Finger millet | 7.3 | 72.0 | 1.3 | 3.6 | 2.7 | 325<br>44 | 283 |
| Foxtail millet | 12.3 | 60.9 | 4.3 | 8.0 | 3.3 | 31 | 290 |
| Proso millet | 12.5 | 70.4 | 1.1 | 2.2 | 1.9 | 14 | 206 |
| Barnyard millet | 11.6 | 74.3 | 5.8 | 14.7 | 4.7 | 14 | 121 |
| Rice | 6.8 | 78.2 | 0.5 | 0.2 | 0.6 | 10 | 160 |
| Wheat | 11.8 | 71.2 | 1.5 | 1.2 | 1.5 | 41 | 306 |
| Maize | 11.5 | 66.2 | 3.6 | 2.7 | 1.5 | 20 | 348 |
| Barley | 11.5 | 69.6 | 1.3 | 3.9 | 1.2 | 26 | 215 |

Parameters (per 100g of seed)

**Source: National Institute of Nutrition (NIN), Hyderabad**

**Role of Government in Millet Promotion**

The Government of India has realized the value of millets in ensuring the nutritional security in the country and made series of efforts such as gazetting millets as Nutri-Cereals, the declaration of the National Year of Millets in 2018. Declaration of International year of millets by UNGA with India along with the support of more than 70 nations is an important step in popularizing millets across

the world with India in the lead. The IYoM 2023 is offing the mandate to scale up the interventions for increasing the millets area and production, and diversifying the processing machinery and technologies, and thus to cater to various segments in domestic and export markets.

**Important initiatives and schemes undertaken to promote production processing and value addition of millets in India:**

1) **Initiative for Nutritional Security through Intensive Millets Promotion (INSIMP)** was introduced in 2012 as a part of the Rashtriya Krishi Vikas Yojana (RKVY). The scheme aimed to demonstrate the improved production and post-harvest technologies in an integrated manner with visible impact to catalyse increased production of millets in the country. Besides enhancing production of millets, the Scheme through processing and value addition techniques was expected to generate consumer demand for millet-based food products.
2) **Odisha Millet Mission (OMM):** OMM aims to revive millets on farms and plates with simultaneous focus on production, processing, marketing, consumption and inclusion of millets in Government schemes. The program's goal is to address the issues of food and nutrition security through the promotion of native millets. The major objectives of the Odisha Millets Mission (OMM) are to increase productivity of millets crops through improved agronomic practices, increase household consumption, setting up decentralized processing units at block level, better marketing of millets through farmer producer organizations conservation and promotion of local landraces and inclusion of millets in ICDS, MDM and PDS.
3) Comprehensive Revival of Millets cultivation' by tribals in north Coastal Andhra and parts of Rayalaseema is an end-to-end program on Millets Revival in Andhra Pradesh. The program aims to develop tribal, and rain fed areas into MILLET-HUBS that can potentially supply millets to meet growing demand and find its place in the grain economy. This project aims to increase productivity, value addition, household consumption by making ragi biscuits, idli and dosa, setting up of processing centres, marketing support and establishing seed production centres.
4) **Millet Village Scheme** was started by Government of Kerala to promote the cultivation of cereals such as millet, bajra, ragi and maize by setting up a millet village at Attappady. The project aimed at preserving seeds of traditional varieties of millets and ensures food security livelihood for tribals.
5) **Introduction of millets in PDS, mid-day meal:** The Government of India has increased the Minimum support price (MSP) for millets to promote millet cultivation substantially and they were introduced in public distribution system (PDS) and mid-day meals in primary, secondary schools and welfare hostels.
6) Department of Agriculture and Farmers' Welfare has supported in establishing of three Centres of Excellence (CoE) on millets at CCSHAU, Hisar; IIMR, Hyderabad and UAS, Bengaluru. These CoE have come out with many value-added technologies. IIMR alone came out with 70 plus value added technologies with SOPs (including technology dockets) for 30 products which were commercialized under their own brand eatrite, and an equal number of processing machineries were retrofitted and standardized.

**Conclusion and Way Forward**

Consumption of millets as direct food has significantly decreased in India due to policies centred around Green Revolution–led food security from the 1960s onwards. During the journey towards food security, nutritional security was not the main focus, which has resulted in the rise of Non-

Communicable Diseases (NCDs) and current state of malnutrition. The transformative role of millets in preventing lifestyle diseases, the benefits of including millets in public-funded programs and the growing realization of high potential for export markets, are projecting them as immune boosters due to their rich nutritional profile. It is assumed that the world is looking towards India's traditional foods, and it turned to be the mandate of the Government of India to scale up the interventions for enhancing the millets area and production, expanding the private food processing ecosystem, diversifying the processing machinery and technologies and thus to cater to the various segments in domestic and export markets.

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# CACTUS : BEAUTIFYING INDOORS

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**Abstract**
Cacti represent the category of plants requiring less attention and care as compared to others thus rightfully referred as low-maintenance plants. Once established, they can make wonderful indoor houseplants. Even if they need less care, but provision of sufficient light, temperature, water, growing media etc. can't be ignored. More than 17,000 cacti species are available worldwide with varied shapes, sizes and colours ranges. So it is essential to hold a brief knowledge about cacti before adding them to indoor conditions. This article constitutes the type of cacti those can be raised successfully under indoor environment and their growing care requirements during survival period.

**Introduction**
Taking the plants requiring low-maintenance into account, no other than cacti can reach more extreme. Both cacti as well as succulents can be served as great houseplants as they don't need much care and attention once established. There is a saying that "All cacti are succulents, but not all succulents are cacti" as unlike succulents, the members belong to family Cactaceae are equipped with small bump like structures called areoles, those are present on the outer surface of the plants. These areoles serve as the sprouting point for the signature spines, flowers, leaves as well as branches giving the cactus plant numerous attractive forms. The succulents store water in their thick stem or foliage, but the cacti are built specially for their drought tolerance mechanism. In general, cacti undergo a period of dormancy in winter; therefore care should be taken to lessen the irrigation frequency and also lower the intensity of light during that period.

**Growing condition needed for indoor cactus:**
**a. Light:** Cacti love sun. A least of 8 hours of sunlight per day is desirable for most of the varieties. This can be fulfilled either through placing them by south facing window or keeping under skylight to avail maximum sunlight during day time. However care should be taken not to place the cacti under direct midday sun as it may lead to yellow colouration of plants.
**b. Temperature:** Cacti prefer high temperatures and can even thrive well to a temperature range of 70-95$^0$C. Thus they attain active growing period during spring and summer months as their temperature requirement can be satisfied. In the contrast, they become dormant because of prevailing low temperature during winter months.
**c. Water:** During their active growth period in spring-summer, cacti need to be watered more frequently unlike in winter, as they undergo dormancy period where only 2-3 life saving watering can be sufficient. Rather than frequent light irrigation, deep soakings at periodic interval are desirable. Before watering, soil should be let dried completely. The growing pot for cactus must ensure proper drainage facility for draining out excess water.

**d. Soil:** As cacti require well drained condition, use of standard potting soil alone is not desirable as it holds too much water and may lead to rotting at the base of plant. A mixture comprised of perlite or pumice and standard potting mix is considered suitable for growing cactus effectively. The container must ensure sufficient holes to facilitate quicker drainage of excess water.
**e. Fertilizer:** Plants should be fed during active growing and blooming seasons i.e. during spring-summer. As cacti prefer acidic conditions, thus the fertilizers should be selected accordingly. Standard cacti foods are now-a-days made available in the market.
**f. Repotting:** As the growth of cactus is quite slow, therefore there is no need to repot them too often. Unlike other ornamentals which need to be repotted annually, cacti can be raised in the same pot satisfactorily for years.

**Some of the preferred cactus plants for indoors**

**1. Angel Wings Cactus/ Bunny Ear Cactus (*Opuntia microdasys*)**

Equally spaced hair clusters instead of sharp spines are the typical characteristic feature of this cactus. Originated from Mexico, this plant develops cushion like pads up to a maximum height of 60 cm but over the time can seldom reach to 1.5 m across making it the most popular one among the entire indoor cactus grown. The small height can be maintained by regular pruning. It bears flowers of pale yellow color which produce edible red fruits on plants those receiving an entire day of sun.

**2. Rat Tail Cactus (*Aporocactus flagelliformis*)**

Rat tail cactus is a good option for hanging baskets when window space is limited or not available. This Mexican native bears attractive magenta flowers which have been utilized for traditional medicinal preparations in Mexico for curing heart ailments. It is a fast growing cactus where the thick stems can trail up to a length of 92 cm.

**3. African Milk Tree Cactus/ Cathedral Cactus (*Euphorbia trigona*)**

This cactus can reach to a height of about eight 2.44 meters but because of the slow growth rate when grown indoors, can barely attain 1.22 meters of height. Over the ridged stems, small green leaves are developed in between thorns except in Rubra variety the leaves are found to be reddish purple instead of green. The plants are watered monthly twice and proper drainage facility must be ensured for successful establishment.

**4. Saguaro Cactus** (***Carnegiea gigantea***)

Saguaro cacti are popularly found punctuating the landscape of Sonoran desert area, Mexico. These fantastic plants can live up to 200 years and take around 40 years to come to flower. The slow rate of growth enables raising these cacti under indoor environment for several years. It is a light loving plants, thus should be provided with as much light as possible. The cactus is sparingly watered monthly once to meet the requirement.

**5. Old Lady Cactus (*Mammillaria hahniana*)**

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As the name indicates, this cactus produces colonies of small spheres up to 25 cm height having characteristic features white hairs and spines. Fully matured healthy plants may develop a halo pink flower like crown top over the head. This plant particularly enjoys sandy potting mixture and given water weekly once during active period of growth.

**6. Bishop's Cap Cactus/ Star Cactus (*Astrophytum ornatum*)**

This is a simple sphere looking cactus giving a majestic appearance when decorated with gravel in a substantial ceramic pot. The deeply ridged spheres are equipped with stiff spikes and can reach several feet tall making it a potentially large cactus for indoors. The frosty white coating developed on plants may seem like a disease but serves a defense system for protecting plants from scorching sun. In order to accelerate blooming, the plants must be fed with plenty of sunlight (nearly about 10 hours a day).

**7. Christmas Cactus (*Schlumbergera x buckleyi*)**

This is one of the most beautiful members of Cactaceae family featured with soft round spines and smooth segmented leaves. It bears tubular blooms that come in various shades viz. pink, white, red and orange. Christmas cacti are originated from Brazilian rain forests, where they thrive as epiphytes on the branches of tree. These plants relish filtered light and moderate watering. To initiate flowering these plants need to be exposed to cool temperatures in the range of 50-60$^0$F during winter.

**8. Barrel Cactus (*Ferocactus spp.*)**

This is also called as fierce cactus equipped with rigid, long spines covering the body and protecting the juicy edible pulp present inside it. Barrel cactus can survive up to several years and ultimately attain a height of maximum 2.5-3 meters when grown outdoors, but about 0.9-1.0 meters when raised as indoor house plant. Moderate watering along with loose sandy potting mixture can serve best for this cactus.

**10. Moon Cactus (*Gymnocalycium mihanovichii*)**

The moon cactus is a great choice for indoors because of its strikingly bright colour. It is a grafted hybrid of two cacti having a shorter lifespan as compared to the parents. The plant should be placed in area availing indirect light, as too much direct bright light can bring severe damage to it.

**11. Ladyfinger Cactus/ Gold Lace Cactus (*Mammillaria elongata*)**

This tiny cactus can only reach to a height of 15 cm maximum. It produces vibrant white flowers. As Ladyfinger cactus enjoys enough of bright light (both direct and indirect), it need to kept near southern window to serve the purpose.

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**12. Blue Hens and Chicks (*Echeveria glauca*)**

This bluish colour plants can be grown satisfactorily in patio, except in winter when they need to be brought inside in order to protect them from extreme fall in temperature. It looks magnificent round the year, but care should be taken not to overwater it. The cactus can come up well under full sun conditions.

**13. Feather Cactus (*Mammillaria plumosa*)**

The Feather cacti are featured with soft, fluffy, feather like plumes which are originally cushion like structures those shield the sharp and pointed spikes beneath. Because of their low height, they can be considered perfect option for indoor growing. The plants can be soaked along with container and let to be dried out over time instead of copious watering.

**14. Easter Cactus (*Hatiora gaertneri*)**

It is named as Easter cactus because of its typical flowering habit during Easter period. In order to get the blooms every year, the plants need to be provided with cool and humid conditions. The plants must be repotted once in two years.

**15. Melon Cactus/ Turk's Cap Cactus (*Melocactus* spp.)**

They prefer warm conditions with minimum 6 hours of full sun for their growth and development. Moderate watering must be ensured depending upon the growing media condition.

**Conclusion**

The cacti not only thrive under outdoors but also can make wonderful choice for indoor plants. Apart from the above cited cacti, there are many more on the list and can be explored as well. When selecting cacti for indoor garden, care should be taken for choosing pot with sufficient drainage holes which ensures quicker drainage of surplus water. Special cactus foods are now available in market that can help in promoting proper growth as well as health of cactus. Except beautifying indoors, the cacti are also proved to be an excellent purifying agent for improving domestic air quality.

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# HERBICIDE RESISTANCE AND TOLERANCE IN WEEDS AND ITS MANAGEMENT

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## Introduction

Weeds are one of the major biological constraints that limit the productivity. If quantitatively expressed the loss due to weeds averages around 31.5%. A range of herbicides belonging to different chemical groups and having different modes of action have been in widespread use to manage weeds effectively. Herbicides assist in management and restoration of areas invaded by weed species. However, at present this technology faces radical changes in effectiveness under field conditions that lead in different cases to failure of weed control operation. Successive and prolonged applications of some herbicides of the same group or some herbicides with the same mode of action in a field will contribute resistance to herbicides in one or several weed species. Thus, although herbicides provide cost-effective weed control and save labor, overreliance on herbicides with a similar mode of action can rapidly lead to development of herbicide resistance in weeds.

## Herbicide Tolerance

According to the definitions of the WSSA, tolerance is the inborn capacity of plant groups to survive and recreate after herbicide treatment. This infers there was no election or genetic manipulation to make the plant tolerant.

## Herbicide Resistance

Resistance is “the acquired capacity of a plant to survive and propagate after introduction to a dosage of herbicide typically deadly to the wild sort/ to which the original population was susceptible. Resistance may be innately happening or initiated by such strategies as genetic engineering. Herbicide resistance if seen from the agronomical point of view means a weed in a crop that is initially easily controlled by applying a determined herbicide rate, is no longer controlled by the same herbicide, much greater effort is needed to control it or it will not be able to be controlled by the herbicide alone.

**Herbicide resistance in weeds status & severity**

Herbicide resistance in weeds has increased rapidly since 1975, today, there are currently 477 unique cases of herbicide-resistant weeds globally. Weeds have evolved resistance to 21 of the 25 known herbicide sites of action & 152 different herbicides. Herbicide-resistant weeds first became problematic in the USA and Europe in the 1970s and early 1980s due to the repeated applications of atrazine and simazine in maize. Growers turned to the ALS and ACCase inhibitor herbicides in the 1980s and 1990s to control triazine-resistant weeds. Then to glyphosate-resistant crops in the mid-1990s in part to control ALS inhibitor, ACCase inhibitor, and triazine-resistant weeds. Glyphosate-resistant weeds are found in 23 species and 18 countries. The ALS inhibitors (126 resistant species) are most prone to resistance, followed by the triazines (69 species).

**Resistance Testing/Confirming Herbicide Resistant Weeds**

With continued use of the same herbicide for different times, resistant individuals aggregate forming irregular patches while other weeds are controlled. These irregularly shaped patches of a single weed species in the field are an indicator of herbicide resistance, especially when. There are no other apparent application problems. Other weed species on the herbicide label are effectively controlled. Field history indicates extensive use of the same herbicide or herbicides of the same mechanism of action. No or minimal herbicide symptoms appear on the single uncontrolled weed species. However, it takes a relatively long time for the population to shift from susceptible to complete resistant and depends on herbicide, environment, and plant factors.

- **In-situ testing :** The preferred method of confirming herbicide resistant weeds is to conduct whole plant dose response experiments on resistant and susceptible biotypes of same species under green house or growth chamber conditions. Test strips should be applied using herbicide rates appropriate to the current crop growth stage and weed size, plus a double rate. To assess the level of control, conduct weed plant counts more accurately before and after application, Green or dry plant weights.
- **Herbicide resistance seed tests:** Seed tests require collection of suspect weed seed from the field at the end of the season. This seed is generally submitted to a commercial testing service.
- **ED50 :** A view has been adopted calculating ED50, i.e., the rate causing 50 percent effectiveness: a population is resistant if its ED50 is ten times higher than the ED50 of the population used as the susceptible standard (Heap, 2005).

**Herbicide Resistance Management**

- **Use of Alternate herbicides** : Two or more herbicides with different mode of action and degradation pathways should be applied in rotation or as tank-mix, pre-mix or in sequence in order to delay onset of herbicide resistance.
- **Method of crop establishment** :Sowing of wheat on furrow irrigated raised beds system (FIRBS) with Bed Planter can reduce density of *P. minor* and other weeds
- **Stale seed bed :** The early seedbed is designed to germinate weed seeds that have been disturbed and brought to the soil surface during cultivation, so that the young weeds can then be eliminated before they can propagate
- **Implementation of IWM :** Integrated approaches involving judicious combinations of cultural, mechanical, biological and crop and herbicide rotations to reduce the dependence on herbicides. Where available, herbicide applications should be based on economic thresholds

- **Zero tillage/Reduced tillage :** Combining ZT with early seeding (October 25) and residue retention resulted in >80% reduction in emergence of P. minor in wheat. Use herbicide only when necessary and where possible herbicide application should be based on economic threshold. Apply herbicides in tank mixed, pre-packed, or sequential mixtures of multiple site of action. Never use unregistered mixtures, always follow label recommendation. Regularly monitor your crops so that resistant patches can be observed
- **Use of mulches**
- **Fertilizer placement**
- **Crop rotation Cultural practices**
- **Sowing time**
- **Sowing method and seed rate**
- **Selection of variety**

**Conclusion**

Weed management strategies need to focus on reducing selection pressure and delaying onset of herbicide resistance and thereby increasing the effective life of existing herbicides. A structured survey of resistance affected areas is desirable to provide site-specific recommendations as herbicides resistance is highly site specific. Integrated weed management systems by integrating different measures like cultural, mechanical, biological along with chemical measures need to be designed to manage herbicide resistance in weeds. Faulty application of herbicides has been diagnosed as one of the main reasons for poor efficacy of herbicides at farmer fields. Therefore, awareness among the farmers about herbicide use and improved herbicide spray technology, herbicide rotation, by arranging large scale field demonstrations is necessary. Improvement in agronomic crop management will play an integral role in managing herbicide resistant weed populations.

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# LIMITS OF DEADLY HEAT STRESS AND DEHYDRATION IN WOODY PLANTS UNDER SCENARIOS OF CLIMATE CHANGE

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Climate change is predicted to increase the frequency of droughts, heat waves, and other extreme events in which vegetation may be affected. However, little is known about what limits the physiological performance of woody plants under these conditions. Climate change has the potential to affect woody plants in a number of ways. These are based on regional and global effects, with the most severe change effects being related to temperatures and day length. The high temperatures that result from greater summertime heat stress impose high risks for mortality and reduced flowering. On the other hand, rising carbon dioxide concentrations can alter plant physiology and lead to desiccation. The concentration of ammonia has been shown to be related to leaf desiccation and flowering cessation, so it is possible that this will also occur under future conditions. So, identifying common responses in non-structural carbohydrate (NSC) dynamics during tree mortality has proven difficult, and while responses have varied considerably, NSCs can play an important role in mitigating drought stress (O'Brien et al. 2014, Hartmann et al. 2018b). This study will produce useful insights into how climate change effect Plants and their heat stress resilience limits. This research would help in the generation of accurate, first-hand data on climate changed induced impact affects plants and their changing physiological response. So, at present, there is a knowledge gap between heat-induced environmental crises such as climate change and their positive and negative consequences in different climate scenarios. The proposed research is a step forward in filling this knowledge gap.

**Drivers of forest dieback in climate change scenario: Increase in $CO_2$ concentration cause**

a.) Drought
b.) Flooding
c.) Global warming and heat stress

**Causes of increased performance**

d.) Increase in $CO_2/O_2$ ratio
e.) Higher A and lower $P_R$ rates
f.) Reductions in Gs
g.) Higher water use efficiency
h.) Improved tolerance
i.) Increase in growth rates

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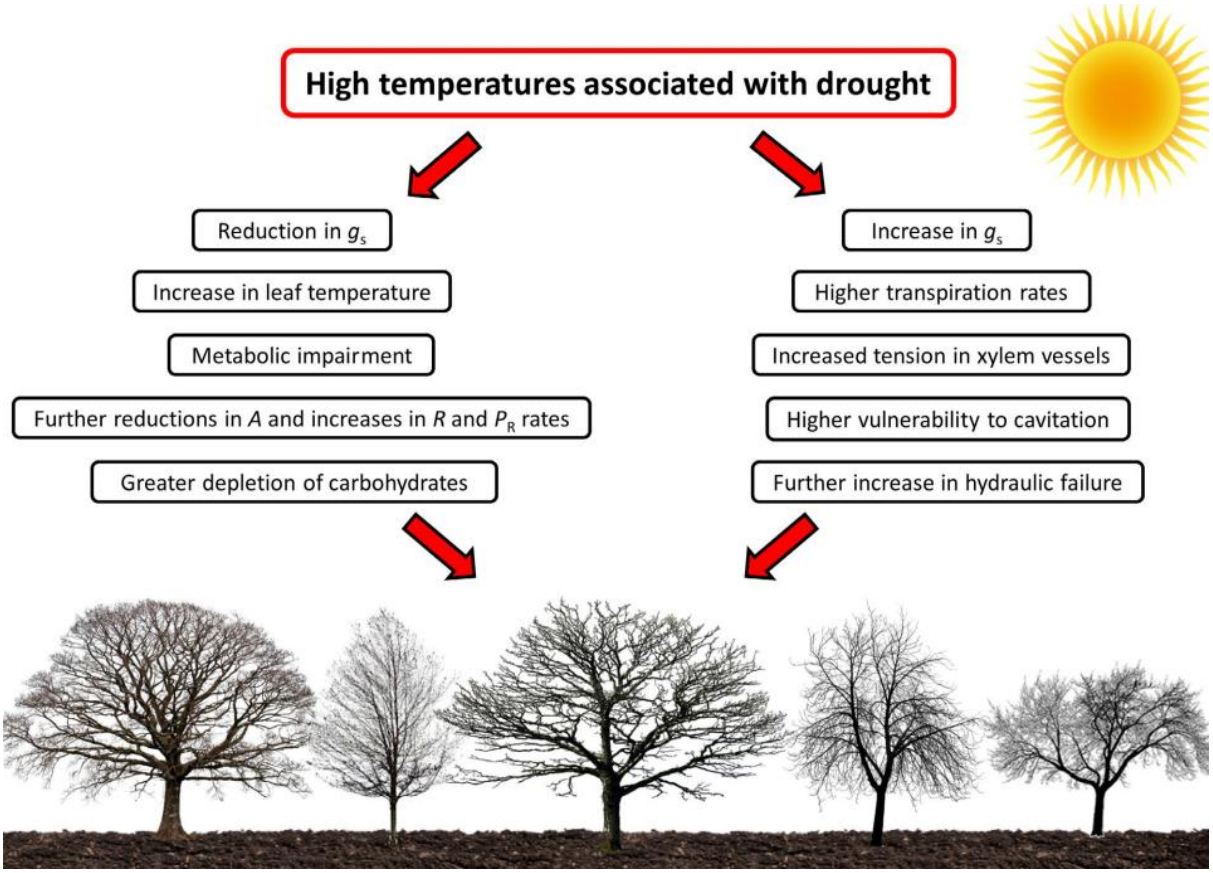


Figure: Climate change makes trees more vulnerable to droughts in a variety of ways. reduction in stomatal conductance (gs ), photosynthesis (A), increases in photorespiration (PR) and respiration (R) rates,

(Source: Silva et.al. 2018)

**Causes of reduced performance**

a.) Carbohydrate accumulation in sink organs
b.) Repression of photosynthesis genes
c.) Down regulation of photosynthesis
d.) Increase in leaf area and reduced root depth
e.) High canopy temperature
f.) Increased vulnerability to cavitation
g.) Increase in leaf temperature
h.) Higher R and Pr rates
i.) N and P limitations
j.) Phenology changes

**Conclusions**

As several research finding reported, there are multiple factor they associated with climate change and they increase threat of numerous species of forest plant extinction globally.It was very important to study the main factor associates with climate change and which lead to plant death. So, it was very important to study multiple stresses that cause plant mortality and long term it causes extinction of species. Furthermore, it is essential to characterize the actual role of $CO_2$, along

with variations in nutrient availability, as they relate to the mitigation or intensification of other stressors. These studies may provide valuable information for the optimization of climate change models and public policies on reforestation and forest management in response to climate change.

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