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सत्यमेव जयते

के. वी. प्रभु (पी.एच.डी.)
अध्यक्ष
K. V. PRABHU (Ph.D)
Chairperson

पौधा किस्म और कृषक अधिकार संरक्षण प्राधिकरण
(संसद के अधिनियम के द्वारा निर्मित सर्वाधिक निकाय)
कृषि एवं किसान कल्याण मंत्रालय
भारत सरकार
नई दिल्ली - 110 012

Protection of Plant Varieties and Farmers' Rights Authority
(A statutory body created by an act of parliament)
Ministry of Agriculture and Farmer Welfare
Government of India
New Delhi - 110 012

MESSAGE

Many congratulations to the Hindustan Agricultural Research & Welfare Society Agra for publishing an International Magazine "Nature Times". I believe that the term "Nature" which includes everything under the sun as well as sun as one ecosystem, the magazine will have sufficient scope in broad coverage to meet the needs of the society at large and scientists deliberating in connected science in network mode.

I wish the magazine all the very best in achieving high quality and international impact and I congratulate Hindustan Agricultural Research & Welfare Society secretary A. K. CHAUDHARY.

(K. V. Prabhu)

Date: 22nd June, 2020

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Message

From the Secretary's Desk

Hindustan Agricultural Research & Welfare society Agra has been in service to educate the farmers of the India since its inception and publication of Nature Times Magazine is one of those means towards this informal way. This Magazine is a regular Science magazine being published annually. I am quite happy that uninterrupted journey of this farmers' friendly magazine has started. Through this Magazine, we try to our level best to make aware very latest, valuable, season-driven and scientifically proven technologies to the farmers for improving their farm practices and inturn to enhance their farm income. The authors of these important articles have shown their keen interest and expertise. I thank to all our authors for their valuable contribution and making this issue a source of knowledge. On behalf of this Society, I would like to express sincere thanks to the Editorial team of Magzine for compiling questions/queries raised. Without proper cooperation of the all society members to bringing out this issue in very sophisticated way.

Dr. A. K. CHAUDHARY
SECRETARY

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Message

From The Editor's Desk

The Indian policymakers and planners right from the inception of the five years plans realized the need to attain self-sufficiency in food grains as one of the crucial goal. As a result of concerted efforts and thanks to the green revolution technology, the nation was able to achieve self- sufficiency in food production. India achieved a record food grains production of 292 million tons during 2019-2020, Which represents a nearly five-fold increase over the output at the time of Independence.

In spite of the above impressive achievements, problems of food security, hunger, malnutrition and under-nutrition still persist. The growing food demand of the burgeoning population and plateauing of food production are also causing concern. There being little possibility of further increasing the cultivable area due to growing urbanization, dwindling water resources, micro-nutrient deficiencies and poor soil health conditions, the demand to produce more food grains in a sustainable and cost-effective manner remains a matter of great challenges.

The National Development Council (NDC) in its 53rd meeting held on 29th May, 2007 adopted a resolution to launch a Food Security Mission comprising rice, wheat and pulses to increase the annual production of rice by 10 million tonnes, wheat by 8 million tonnes and pulses by 2 million tonnes by the end of the Eleventh Plan (2011-12). Accordingly, a Centrally Sponsored Scheme, 'National Food Security Mission' (NFSM), was launched in October 2007.

The Mission met with an overwhelming success and achieved the targeted additional production of rice, wheat and pulses. The Mission continued during 12th Five Year Plan with new targets of additional production of food grains of 25 million tonnes of food grains comprising of 10 million tonnes rice, 8 million tonnes of wheat, 4 million tonnes of pulses and 3 million tonnes of coarse cereals by the end of 12th Five Year Plan. Considering the experience and feedback received from the States major changes were made in approach, norms of financial assistance and programme implementation strategy which are reflected in the revised operational guidelines.

Based on past experience and performance of 12th Plan, it has been decided to continue the programme beyond 12th plan i.e. 2017-18 to 2019-20, which is co-terminus with Fourteenth Finance Commission (FFC) period with new targets to achieve 13 million tonnes of additional food grains production comprising of Rice – 5 million tonnes, Wheat- 3 million tonnes, Pulses- 3 million tonnes and Coarse Cereals- 2 million tonnes by 2019-20

In order to cope up with the growing challenges ahead in agriculture, there is a great deal of need to harmonize policies, programmes and take pragmatic measures such as increasing the cropping intensity, crop diversification, adoption of latest technologies for cereals, millets, pulses, etc.

The present issue of 'Intensive Agriculture' is intended to provide its readers, specially the farmer, a wider, wider choice from the above list to help them understand and follow the practices, which can help improve their production, productivity and incomes.

Dr. Atul Tiwari
Editor

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SUSTAINABLE DEVELOPMENT BY BIODIVERSITY

Dr. Atul Tiwari
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Biodiversity- Why we should Care?

Can you imagine a world without chocolates? Children sure cannot. Well, chocolate is made from cocoa that grows on cocoa trees, mostly in the wild in the Amazon in South America. But for commercial cultivation, varieties of cocoa threes are derived from the wild plants and these have now travelled to other tropical countries as well. These commercial cocoa verities are often attacked by pests and diseases such as “pod borer” and “swollen shoot”. Growers try to overcome this problem by constantly cross breeding the commercial cocoa varieties with wild varieties, which are naturally resistant. So, every time a new disease surfaces, breeders run back to the wild.

That's the power of biological diversity.
Similarly, in Ireland farmers used to depend on a single variety of potato. But in 1845 and 1846 this variety of potato was suddenly attacked by few fungal diseases, called potato blight. This lead to a horrific famine, killing more than a million peoples: thousands of those that survived migrated to Australia.

That's the consequence of ignoring biological diversity.
There are almost 3 million to 100 million species inhabiting the earth. Of these, hardly 1,435,662 have been identified. Yet today, approximately 27,000 species become extinct every year. If this trend of biodiversity depletion continues, one-fourth of the world's species may be gone by the year 2050.

Now, that's the destructive potential of mankind.

While evolution of a new species or a new variety can take tens of thousands, even millions of years, extinction can happen in a decade. It is true that as arule of nature, extinctions of species happen all the time. But current extinction rates, running anywhere from 100 to 1000 times the natural rate, rival those of the five greatest mass extinctions in world history. But, while the earlier mass extinctions of species were attributed to their inability to adapt to changing environment, recent species losses are the direct result of change resulting from human growth that have managed to disrupt and damage vital links. (Like in Corona case)

Everyone loves nature. But nature is loveable because of the mindboggling diversity it has to offer. Biological diversity contributes to human society in more ways than we could ever imagine. Of course, it does provide us with food, fiber, timber, energy, pharmaceuticals, raw materials and industrial chemicals. It also plays a significant role in purification of water and air, pollination, absorption of carbon by trees, renewed oxygen supply, natural pest control, flood and erosion control and the absorption and detoxification of human and industrial wastes.

But today, biological diversity is thowing up novel solutions for problems created by humans. Take for instance, bio-remediation, where the use of living organisms that gobble up polluting sensitive indicators to environmental clean-up. Then there are innumerable species that act as very sensitive indicators to environmental change (Like showed in Corona cases)

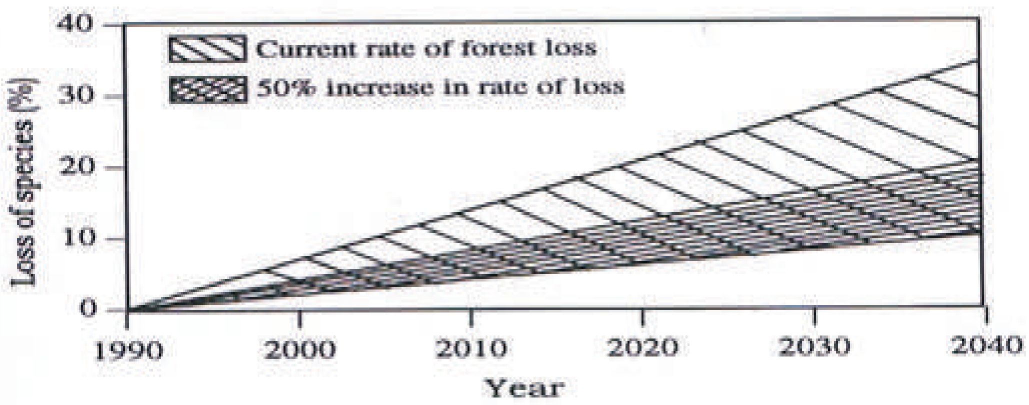
Another example is that of coastal ecosystems- mangrove swamps, coral reefs, sand dunes and salt marshes- which are today being looked upon as butters against sea level rise, storm surges and extreme weather events, like tsunami and cyclones.

Climate change is the buzzword today. People are now more aware of the hazards of climate change. But few are able to appreciate concerns relating to the loss of biodiversity whose importance is often underestimated or misunderstood. And loss of biodiversity is happening everywhere – not just in the forests. Wetlands are shrinking and innumerable species are threatened with extinction.

With concern to human being, we have complex cell structure and Corona like microbes have unicellular cell structure. So as compare to human being in changing climatic conditions, microbe can easily change their genetic sequences as per requirement by their body and develop their mutant variety in nature and survive better. Human beings face problems either in the form of diseases or resources scarcity, if we not sustain our climate and nature.

Public understanding of such issues is extremely important if we have to make any headway in conserving biodiversity for benefit of the future generations. After all, a rich biodiversity works for the benefit of all and any damage to biodiversity and climatic condition will impact us all.

Fig. 1.1 : Per cent of Tropical Forest Species Likely to be Sentenced to Extinction in Coming Decades



Source: Ehrlichand Wilson, 1991; Ried, 1992.

We can achieve Sustainable concept for our future generation with help following Indian Government Action Plan- 8

- Solar Mission
- Sustainable Habitats
- Water Mission
- Sustaining the Himalayan Eco-system
- Green India(33% Green cover)
- Sustainable Agriculture by Biotechnology
- Strategic Knowledge (Research on Climatic Change)

Conclusion

It is good to have increased food production which might have helped reducing the number of undernourished people.

The first of the Millennium Development Goals (MDGs) is to:

Eradicate Extreme Poverty and Hunger
The seventh of the MDGs is to:

Ensure Environmental Sustainability

How to achieve both the goals simultaneously?

By Innovative and Traditional Technology

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AN OVERVIEW OF ENVIRONMENTAL ACCOUNTING

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Few decades ago a hand full people were aware of economics beyond their own jobs and expenses, and few companies thought beyond the economics of their profit and loss statements. Industries were neither clean nor green, and gave little consideration to the environmental impact of their business.

In the late 19th century some industrial passionate about the natural beauty of the country in which we live advocated for its protection and appreciation, and the environmental movement was born and supported by the action of a president who established the National Park System, and a man by the name of John Muir who mused over the beauty of a valley called Yosemite. Those simple actions helped grow an awareness of the value of the world in which we live, and our obligations to it as stewards. As that awareness grew the public and industry alike began to see the potential for major environmental problems. This realization brought environmentalism into the world of business.

In 1970, the environmental accounting has emerged as a consequence of a growth in environmental consciousness and concerns about environmental and social welfare (Khalid, Lord& Dixon, 2012). It is easily existed through sustainability and annual reports as well other reporting media, in comparison , management accounting information that is concerned to operations is considered to be confidential and internal (Weale, 1991) .

Norway was one of the first. Influenced by the publication of Limits to Growth (Meadows et al. 1972) and a burgeoning environmental movement, Norwegian officials were concerned that their natural resources, on which their economy is relatively dependent compared with other European countries, would run out. The Netherlands was also a leader in the development and adoption of environmental accounting. Dutch interest in this area originated with the work of Roefie Hueting, who developed and sought to implement a measure of sustainable national income that would take into account the degradation and depletion of environmental assets resulting from economic activity. US Environmental Protection Agency (EPA)

Undertook the development of a set of pilot accounts for the Chesapeake Bay region of the eastern United States (Grambsch et al. 1989).

Today businesses face a ladder of environmental regulations and industries from manufacturing to technology must now consider their ecologic and social impact.

Environment Accounting Definition and Role

Environmental accounting, also called green accounting, refers to modification of the System of National Accounts to incorporate the use or depletion of natural resources. Environmental accounting is a vital tool to assist in the management of environmental and operational costs of natural resources. Valuation of natural resources is an essential input into both social cost benefits analysis and some approaches. Natural resource accounting is important for sectors like forests, water, and ecosystem services (Iyanki V. Muralikrishna and Valli Manickam 2017).

Environmental accounting is an important tool for understanding the role played by the Natural environment in the economy. Environmental accounts provide data which highlight both the contribution of natural resources to economic well-being and the costs imposed by pollution or resource degradation. Environmental accounting is that field which deals with the resource use, communicates and measures cost of national economic effect or company effect on the environment (Deegan, 2013b). The costs have included clean -up costs or remediate of clean polluted sites, environmental penalties and taxes, buy of techniques that prevent pollution and costs of waste management. The system of environmental accounting includes two types of accounting, the first one is environmentally differentiated conventional accounting and the second one is ecological accounting. In environmentally differentiated accounting , we measure the impacts of the natural environment on a company in financial terms while ecological accounting measure the company impact on the environment but according to physical measurements . (Zhan & Zhang, 2013).

There are various components of environment accounting

Environmental management accounting (EMA)

- Environmental cost modelling and resource economic
- Environmental financial accounting (EFA)
- Environmental reporting
- Assurance and Auditing for environmental aspects in the financial statements.

According to Seakle KB Godschalk (2004) EMA is becoming increasingly relevant as international experience shows that by applying EMA methodology, companies can track close to 20% of total annual operating costs not currently recognised as environmental costs, and realise the large embedded savings potential and revenue gains. Environmental cost models can be powerful tools to help identify areas of wastage and potential savings.EFA refers to the way in which environmental issues impact on the financial statements of companies and the accounting 'rules' that govern the recognition and disclosure of these issues in the balance sheet, income statement and related aspects of the annual financial report.EFA refers to the way in which environmental issues impact on the financial statements of companies and the accounting 'rules' that govern the recognition and disclosure of these issues in the balance sheet, income statement and related aspects of the annual financial report. The consideration of environmental matters in the audit of financial statements is a logical consequence of EFA International Audit Practice Statement 1010covers this component of environmental accounting

Conclusion

Environmental accounting is a fairly interdisciplinary approach that integrates environmental and accounting issues. Substantial development of this field has still to take place. There are four key methodological challenges in developing green or ecosystem accounts, such as, the definition of ecosystem services related to accounting, , the treatment of degradation and rehabilitation, distribution to institutional sectors, and valuing environment system services that are consistent with SNA principle.It is important for people, regions, and administrations involved in enterprises to correctly. Evaluate such attempts by the enterprises and be able to prepare the system that can support the attempts for the entire society.The management should undertake important role in helping to environment protection against pollutingmanufacturing companies in addition to find out thehow to record the spent expenditures in accountsor how they can be disclosure.These are the matters that accounting with proceeding to them shall provide a suitable policy andinformation to management.

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QUINOA FOR FOOD SECURITY IN INDIA UNDER MARGINAL ENVIRONMENT

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India is agriculture based country where 54% people directly depend on agricultural profession. Green revolution made India self-sufficient in food grains, but, climate change has hit this sector most violently leading to a fear of food insecurity. Traditional crops like wheat, rice and other cereals used as staple food, get affected due to increasing biotic and abiotic stresses like insect-pest infestation, drought, floods, soil salinity, water logging and nutrient deficiency. This has reinvigorated the efforts to search for an alternative crop full of nutrition, but, strong enough to withstand to biotic and abiotic stresses.

Quinoa (Chenopodium quinoa willd) can be the best alternative crop with highest potential to provide food security, nutritional security, health security and better opportunities for the development of food industries. It is nutrient rich food which provides a complete & gluten free protein, best source of carbohydrates (low glycemic index), more fiber, dietary minerals, tocopherols and Phyto-steroids (Omega-3, 6& 9). Narratively, it can be termed as “Superfood”, “Power food” and “Mother of all grains”. As per FAO, quinoa is only the staple food for growing global population to provide food security in the next century. It is only the single food which can supply complete protein, all essential life sustaining nutrients and can reduce the risk of various diseases like blood cholesterol, blood pressure, diabetes, sexual weakness, etc. in very effective and preventive way. NASA considered quinoa as great food to take it into space as it feeds for a longer period of time with more stabilization of blood sugar and fluctuation in energy level. Quinoa' ability to produce high protein grains under ecologically extreme conditions makes it important for the diversification of future agricultural systems, especially in high altitude areas of the Himalayas and North Indian plains under marginal environment.

In developed countries, quinoa attained top position to provide food security and better opportunities to the development of food Industries. However, in India, quinoa remains un-familiar to majority of the people and its commercial potential and benefits are still untapped. Indian Medicinal Plants Marketing Federation is only the agency who introduced, tested, promoted and successfully established quinoa first time in India through implementation of a National-level Quinoa Development Programme entitled “Integrated Quinoa Development Project” being implemented in 75 districts of 7 states since 2009.

Origin & Distribution:

Quinoa is a plant of South America and originated in the area surrounding Lake Titicaca (the world's highest most saline water reservoir) in Peru and Bolivia. It is presently cultivated in Bolivia, Peru & Ecuador in South America and United States of America. Cultivation of quinoa is spreading throughout the world and presently being cultivated in more than 70 countries including United States of America, Australia, France, England, Sweden, Denmark, Holland, Kenya, and Italy.

Type of quinoa

According to taste, there are two main types i.e. bitter quinoa and Sweet quinoa. Bitter quinoa, also known as Royal Quinoa, is the most

valued and popular because of their large size grains and high content of saponin that provides a bitter taste. According to color, quinoa is differentiated mainly in 4 types i.e. white, red, black and multi-colored. White quinoa is most common, sweeter than other types, similar to rice in taste and available in most of the local supermarkets.

Morphology of quinoa plant:

Quinoa is an annual, herbaceous dicot plant that reaches to a height of 0.5 to 1.5 m. The main stem may be branched or without branching. Leaves are of various colors, roots are well-developed, highly ramified tap-root penetrate in the soil as deep as 1.5m which make quinoa plants more resistant to drought. Quinoa bears hermaphrodite and uni-sexual flowers which are usually self-pollinated (10 to 15%cross pollination). The inflorescence is racemes of 15–70 cm length rising in the axils of lower leaves at top of the plant. The fruit is an achene, comprising several layers. The outer layer determines the color of the seed and contains saponin. The seeds are generally flat, oval-shaped with 2 mm in diameter and produced in large clusters on a panicle. Seeds do not exhibit dormancy and may remain viable for two or three years without germination.

Composition of grains:

Quinoa grains contain 12–23% protein, 58 to 68% starch, 1.3% to 6.1% dietary fiber, 5.2 to 9.5% oil and easily absorbable minerals i.e. 46 to 340 mg calcium, 270 mg/100 g magnesium, 4.8 mg /100 g, 0.12 to 0.53 mg Vitamin-A and 4.60 to 5.90 mg vitamin-E /100 g dry matter. Quinoa protein is gluten free (stomach upset inducing substance), complete and rich in lysine (5.1–6.4%) & methionine (0.4–1%) which are deficient in cereals. Essential amino acids are found in the nucleus of the grain unlike other cereals (rice, wheat) in which they are located in their exosphere or hull. The main carbohydrates are starch (with 22% digestibility), sugars and dietary fibers, making it an ideal source of energy that is slowly released into the body. The grains contain free sugars (about 5%) and are rich source of soluble &insoluble dietary fiber, which detoxify the body, eliminate toxins, harmful waste products and makes quinoa an ideal food. Oil is nutritionally rich and stable with highest percentage of fatty acids i.e. 50.24 - 56% Omega-6 (linoleic acid), 21.1 - 26.04% Omega-9 (oleic acid), 4.77 – 6.7% Omega-3 and 9.59% palmitic acid.

Therapeutic properties:

Quinoa grains, stems and leaves have good medicinal value. It improve glucose tolerance and reduces insulin requirement and blood cholesterol. Quinoa can help to prevent decalcification and osteoporosis. Anaphrodisiac, it improve ability of better erection man and reduces infertility in women. Quercetin is beneficial in atherosclerosis (hardening of arteries), circulatory problems and heart diseases. Quinoa grains are rich in anti-oxidants (flavone glycosides). Soluble fiber reduces blood sugar level, cholesterol & weight loss, the risk of high blood pressure, heart attack and prevent cardio-vascular diseases. Quinoa is effective in weight and obesity control as it is zero-cholesterol, low fat and rich in dietary fibers. Magnesium, manganese, and phosphorus present in good amount are helpful in reducing migraine headaches. Magnesium rich grains relaxes Blood vessels and prevents high blood pressure. Lignin is beneficial to heart. Quinoa helps in reducing the LDL (bad cholesterol) and increases HDL (good cholesterol) in the body due to its omega-3 and omega-6 content. Due to low glycemic index, it is an ideal food for people suffering from diabetes. Quinoa is good for insomnia, combats dandruff and is a good hair tonic. The decoction of quinoa grains, sweetened with honey, is a proven remedy against bronchial disorders, colds, cough, and inflammation of the tonsils. The soup of quinoa grains is nutritive tonic which increases breast milkand protects against tuberculosis.

CULTIVATION TECHNIQUES:

The scientific cultivation practices standardized at national-level under Quinoa development programme are summarized hereunder:

Climatic requirement: Quinoa adapts from desert too hot /dry regions and require cool climate for its cultivation. The ideal temperature for good growth of plants is 15° to 20° C. Extreme hot weather and warm nights inhibit fruit set.

Quinoa needs dry condition during seed maturation and harvesting. It is quite hardy and frost resistant and light frost normally does not affect the plants at any stage if the soil is dry.

Soil and field preparation: Quinoa can be grown in poor soils, but, it perform better in well drained and fertile sandy to sandy loam soils having pH 6.5 to 7.5. Heavy clay soils with very high or very low soil pH are unfit. Quinoa is found to be one of the few crop plants grown in the salt-affected soils. However, high salinity influences plant growth, seed yield, and seed quality. Two to three ploughings followed by planking are needed for field preparation. There should be a better drainage system to avoid water logging condition.

Sowing: In North region, the best time for quinoa seed sowing is from October to November. In Southern states, the best sowing time is from late August to mid-November, while in the Central region, the ideal sowing time is from mid-October to mid-November. If sowing is done much early, the seeds of quinoa may not germinate due to high night-temperatures. Best germination occurs when soil temperature range from 18-24° C at the time of sowing. Seeds may be sown by broadcasting method or by seed drill in lines, maintaining 40 to 50 cm spacing in rows, 30 cm in plant to plant and 2 to 3 cm seed depth. 200 to 250 plants per square meter and 6 to 8 kg seed rate / ha are found ideal under field testing.

Fertilizer application: About 80 Kg Nitrogen, 40 Kg Phosphorus and 45 Kg Potash per hectare is recommended for obtaining higher yield. High dose of N, P & K beyond this level, damages roots, reduces the availability of other nutrients resulted intense lodging and ultimately poor yield. Heavy dose of Nitrogen may lead accumulation of nitrates in grains, while, heavy doses of phosphorus and potash are found to increase vegetative growth of plants without any increase in seed yield.

Nitrogen is required by quinoa plants throughout growth period, therefore, it is recommended to apply Nitrogenous fertilizers in split doses throughout the growth period. Phosphorus and potash are required in early root development and early plant growth, therefore, entire quantity of these nutrients should be applied before seed sowing. In sandy soils, split application of nitrogenous and potassic fertilizers is desirable.

Weeding: After emergence, weeds pose a major threat during first two weeks due to slow growth of quinoa plants and rapid growth of weeds. If weeds are allowed to grow, they may cause drastic reduction in gain yield up to 25%. Herbicides are not recommended in quinoa cultivation owing to deterioration in grain quality; therefore, it is more relevant to control weed population in quinoa field by hand weeding.

Irrigation: Quinoa is a highly water efficient plant, drought-tolerant and resistant to lack of soil moisture. Therefore, only3 irrigations i.e. at 5-12 leaf development, flowering, and grain filling stages, are recommended for obtaining good yields. Excess watering or more irrigation should be avoided in the seedling stage.

Insect-pest & diseases:

The most economically important pests identified in Indian conditions are quinoa moths (Eurysacca quinoa and Eurysacca melanocampta) and the ticona complex (Copitarsia turbata, Heliothis titicaquensis, Spodoptera species). Quinoa moths is the main pest in North India causing major loss of gran yield. The adult of moth feeds on flower nectar and is not itself harmful to the quinoa crop. The larvae attack the crop in development stage i.e. from November to December and in maturation phase i.e. March-April.

Ticona complexis another serious pest. The adult of ticona complex is a nocturnal butterfly that is attracted by the light. The newly emerged larvae scrape the mesophyll of the leaves and eat the parenchyma and cut the young plants near ground causing them to collapse and die. When the larval population is high, they destroy buds, flowers, and glomerules, in addition to drilling shoots and stems.

Quinoa is infected by a variety of pathogens, which cause several diseases i.e. damping off (Sclerotium rolfsii), downy mildew (Peronospora farinose), stalk rot (Phomaexigua var. foveata), leaf spot (Ascochyta hyalospora), grey mold (Botrytis cinerea), and bacterial blight (Pseudomonas sp.)which cause yield reduction from 8 to 23% in India. The Downy mildew occurs during the flower-bud initiation stageand

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thereafter, incidence gradually decreased. Quinoa showed high level of resistance towards downy mildew in North-Indian conditions.

Harvesting and yield:

Quinoa is harvested at physiological maturity stage which comes when the leaves have fallen leaving just the dried seed-heads and grains become dry & hard. Usually quinoa is harvested traditionally by pulling out the plants by hand. It can also be harvested by cutting plants with a sickle between 10and 15 cm above the soil.

Farmers generally get 6 to 8 quintal grain yield per Acre in India. However, in the experiments conducted under Integrated Quinoa Development Project, highest yield of 18 quintal per Acre is recorded.

Post-harvest handling, Processing & storage:

After harvesting, it is important to dry crop well to avoid occurrence of mold during storage. After drying, crop is threshed manually through beating panicles by a stick on platform or by threshers, after adjusting their hulling and sieving systems. After winnowing, grains can be cleaned and graded using screens. Grains should be thoroughly dried before storage and may be stored in a clean, cool, dry and ventilated environment. For storage, quinoa grains should be filled in good quality poly-propylene bags or in air-tight containers and kept on a wooden pallet.

Uses of quinoa:

Quinoa is used mainly as nutritive food i.e. making of breads, baby foods, soups, mixed grain dishes, biscuits, drinks, alcoholic beverage and extrudes. Now a days, several processed and semi-processed food-products are available in the markets throughout the world. Most common products are ready-to-eat grains usually eaten as breakfast, i.e. puffed, pasta, cakes, Flakes, dry noodle, extruded, grated and hot cereals. Quinoa is also used as animal feed, potential green manure, manufacturing of cosmetics and pharmaceuticals. Quinoa oil press cake could be an important complementary protein for improving the nutritional quality of animal food stuffs. he saponins obtained from quinoa grains may have some potential uses in detergent, shampoo, soap, body lotion and insecticides making.

Fig. 1: Quinoa grains

Fig. 2: Bumper crop of quinoa (Variety: Sarvati / DN-7)

Fig. 3 : Panicles of Sarvati (S-7) variety

Fig. 4 : Manual threshing

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SEED PRODUCTION TECHNOLOGY FOR RAPESEED-MUSTARD

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Introduction

India is ideally suited for growing all the major annual oilseed crops. Among the nine oilseed crops grown in the country, seven are edible (soybean, groundnut, rapeseed-mustard, sunflower, sesame, safflower, and niger), and two non-edible oils (castor and linseed). Among these oilseed crops, the share of rapeseed-mustard is about one fourth of total area and one-third of total oil production in the country. Rapeseed-mustard is the major source of income especially for the marginal-and small-farmers in rainfed areas which are about 25% of the total cultivated area. Due to low water requirement and feasibility of rapeseed-mustard, it suits and adapts well in different cropping systems. It is cultivated across the country mainly in Rajasthan, Madhya Pradesh, Uttar Pradesh, Haryana, West Bengal, Asom and Gujarat which contribute maximum to its production (>93%) and acreage (>91%) and now its cultivation is also being extended to nontraditional areas of Karnataka, Tamil Nadu, Telangana and Andhra Pradesh (Sharma et al. 2018).

Rapeseed-mustard, commonly referred as oilseed Brassicas, constitutes an important group of oilseed crops. This unique group of crops having different kinds of breeding behaviour. Among the Brassica species few are self compatible (self pollinated) crops i.e. Yellow sarson (Brassica rapa var yellow sarson), Gobhi sarson (Brassica napus) and Ethiopian mustard (Brassica carinata) while on the other hand few Brassica species are self incompatible (cross pollinated) crops including toria (Brassica rapa var toria), brown sarson (Brassica rapa var brown sarson) and taramira (Eruca sativa). In addition, Indian mustard (Brassica juncea), the major crop of this group, in which cross-pollination ranges from 5 to 15 per cent. Indian mustard (Brassica juncea L.), popularly known as 'raya' or 'laha' is a predominant rabi oilseed crop in India. The cultivation of rapeseed-mustard in Rajasthan is largely carried out under rainfed farming systems where sowing commences after south-west monsoon rains (Ram et al., 2017).

India is predominately agrarian country and agriculture contributes around 14% of gross domestic product (GDP). Agriculture as a livelihood, directly supports 59% of Indian work force thus, any technology intervention will have multifold effect on millions of poor people engaged in agriculture and allied activities. Over the last few decades, national seed research system able to overcome many challenges in field of seed science and technology resulting in supply of improved seeds to end-users. Total quality seed distribution through public sector shows increasing trend in availability of quality seed to farmers. Therefore, production of genetically pure, quality seed following scientific principles and supply to the farmers especially resource poor farmers at affordable prices is pre-

requisite for increasing and sustaining Agricultural production in the country.

What are Seeds ?:

Botanically seed is the ripened ovule in the ovary of a flower. It contains the embryo which has developed after fertilization of the male and female gametes in the embryo sac of the ovule. In Seed science, the seed is any part or organ of the plant which has capability to regenerate a new plant. The seed has the potentiality to maintain the intrinsic qualities through generations of the variety or species to which it belongs.

Seed is a vehicle for delivery of improved technologies and is mirror for port yard of inherent genetic potential of a variety/ hybrid (Ram. et al. 2016). Seed can play pivotal role in achieving higher productivity, use of quality seeds alone could increase productivity by 15-20% highlights the important role of seed in agriculture. Seed is the critical input for achieving sustainable production and efficacy of all other inputs depends upon quality supply of seed to farmers at right time.

Seed provide a way for species to survive in addition to protecting and sustaining other life. By way of seeds, embryonic life can be practically suspended and then revived to develop again. Seeds are raw materials for innumerable products, important to human beings and animals. Seed are a source of wonder and objects of earnest inquiry in our ceaseless search for an understanding of living things. Unwanted kinds of seeds, such as weeds, can be enemies and source of trouble.

DIFFERENCE BETWEEN SEED AND GRAIN

SEED	GRAIN
Always alive and sensitive to light, air and moisture.	May be alive or dead. May or may not be sensitive to light, air and moisture.
May be used as food grain, it not treated with poisonous chemicals.	Grain should not or cannot be used as seed.
Seed should have sufficient vigour.	Vigour may not be present in grains.
Specific varietal quality characteristics e.g. purity, germination are more	Nutritional characters are more important
Normal healthy seedling after germination is essential.	Abnormal weak seedling may germinate, as germination is not required.
Requires proper temperature and relative humidity for better storage to maintain viability.	Proper temperature and relative humidity is not important.
Inspection and suggestion by seed technologist/ agricultural scientist are necessary.	Generally not necessary.
Seed production according to Seed Act and Seed Rule.	No such act or rules are necessary.

General Seed Standards

1. `Classes and stage of seed multiplication
   A. Nucleus seed: It is the original or first seed of a variety available with producing breeder, i.e., the breeder, who developed the variety in question, or any other recognized breeder of the crop. This seed has 100% genetic and physical purity alongwith high standards of all other quality parameters. Nucleus seed is multiplied and maintained by selecting individual pods/spikes/plants and growing

individual pod/plant progenies. This processis repeated continuously, as a result of which nucleus seed is available only in small quantities. It carries breeder's certificates. Used for breeder seed multiplication.

pods/spikes/plants and growing individual pod/plant progenies. This`process is repeated continuously, as a result of which nucleus seed is available only in small quantities. It carries breeder's certificates. Used for breeder seed multiplication.

B. Breeder seed: Breeder seed is the progeny of nucleus seed, the source of foundation seed, and is produced by the originating plant breeder who developed the variety, or any other institution or qualified breeder recognized by the authorities. Breeder seed production is the mandate of ICAR and is undertaken with the help of ICAR Research Institutes. Breeder seed is genetically so pure as to guarantee that the subsequent seed class (foundation seed) shall conform to the prescribed standards of genetic purity. It carries golden yellow tag.

C. Foundation seed: This is the progeny of the breeder seed. Bags of foundation seed carry tags of white color, which contain information about seed quality. The responsibility for production of foundation seed lies with NSC, State Farms Corporation of India (SFCI), SSCs, State Departments of Agriculture and private seed producers having necessary infrastructure facilities. It can be used for Foundation stage-I to Foundation stage-II multiplication on specific cases for the open pollinated varieties with specific approval from the Director of Seed Certification. It is used for certified seed multiplication.

D. Certified seed: Certified seed is the progeny of foundation seed, and it must meet the standards of seed certification prescribed in the Indian Minimum Seed Certification Standards, 1988. Certified seed can also be the progeny of certified seed provided this reproduction does not exceed three generations including foundation seed stage I. Certified seed produced from foundation seed is called certified seed stage I, while that produced by multiplication of certified seed itself is called certified seed stage II. Certified seed stage II cannot be used for further seed multiplication. The tag of certified seed is of blue color (shade ISI N. 104, azure blue), and carries all the relevant information about the certified seed lot contained in the bag. The production and distribution of quality/certified seeds is primarily the responsibility of state government, and is organized through SSCs, department of agriculture farms, cooperatives etc. In addition, NSC and SFCI produced certified seeds of varieties of national importance.

E. ***Labeled seed:*** The labeled seed is produced by the producer himself and no role of certification agencies. Seed carries producer label of opal green color with all details of seed standards and signed by the producer himself. Producer himself is responsible for varietal purity and seed standards.

2. **Eligible Varieties and parental Constituents:**
Only the varieties notified under section (5) of the seed Act, 1966 are eligible for certification under IMSCS 1988, based on value for cultivation and use (VCU) systems.

3. Control of the Production of the Seed: Nucleus seed production is purely under the control of Breeder. Breeder seed is produced by breeder and monitored by a team comprising of breeder, concerned Assit. Director of seed certification and a member from NSC and a nominated member from farming community. Foundation and certified seeds are certified and labeled/tagged by certification agencies as per IMSCS. Under Indian system, for certified seed production only official inspectors are allowed and seed analysis is carried out in Notified Seed Testing laboratories.

4. Seed sampling: Seed sampling shall be made by the officials of certification agency only. No provision of authorization of non-

official persons to carry out, under official supervision seed sampling, fastening and labeling of containers.

5. Seed Analysis: Seed analysis is conducted in the Notified Seed Testing Laboratory as per seed standards prescribed under IMSCS and procedure adopted from the seed testing manual.
6. Seed Sample Storage: Guard samples of each seed lot shall be preserved for 2 years from the date of grant/extension of the certificate and 4 years in respect of rejected seed lots.
7. Pre and Post Control Tests: As per IMSCS, seed certification agency shall conduct GOT wherever it is a pre-requisite and where a doubt has arisen about the genetic purity. No provision of pre and post control tests.
8. Issue of certificates: Release order (Form-II) issued by the officers of SSCA for Foundation and Certified class and for Breeder seed by the concerned scientist in –charge of production.

Requirements for Seed Certification

Seed has to meet certain rigid requirements for certification. It must be seed of an improved variety released by either the central or a state variety release committee for general cultivation and notified to that effect by the Ministry of Agriculture, Government of India; this is essential for the seed to be certified.

Genetic purity: Genetic purity means the absence of seeds of other varieties of the same crop as well as of other crop species. Genetic purity ensures that the seed is of the variety under certification, and that there is no mixture from other varieties or other crops. The standard of genetic purity is very high, and the amount of contamination permitted ranges up to 0.5 per cent in case of rapeseed-mustard.

Physical purity: Physical purity implies freedom of seed from inert matter and defective seed. Inert matter consists of nonliving materials, such as sand, pebbles, soil particle, straw, etc. Defective seeds are those seeds that are broken, diseased, insect-infected, shriveled and unfit for germination. A broken seed larger than half of the normal seed is not considered defective provided its embryo is not damaged. The total amount of permissible contamination by inert matter and defective seed not more than 3.0 per cent in case of rapeseed-mustard.

Germination: A high percentage of germination is necessary to obtain a good crop stand with the minimum amount of seed. The percentage of germination required for certification varies from one crop to the other; it is moderate in a crop like rapeseed-mustard (85%).

Freedom from weed seeds: Freedom from weed seeds is necessary to prevent weeds from spreading through seed and reduce losses caused by weeds. The maximum amount of weed seeds permitted is very low; 10/kg weed seeds are permissible in rapeseed-mustard.

Freedom from Diseases: The certified seed must be free from seed-borne diseases. If the seed is contaminated with pathogens, it is likely to lead to an epidemic and even a total loss of the crop. The presence of seed-borne pathogens is prevented in the following two ways: (i) by effective control of diseases in the standing seed crops, and (ii) by treating seeds with disinfectants and protectants.

Moisture content: Seeds must be dried to an optimum moisture level for efficient processing and safe storage. The level of optimum moisture varies from one crop to another, e.g. 8% for rapeseed-mustard. Moisture content higher than the recommended level (1) leads to a loss in seed viability, (2) promotes growth of microorganism, particularly molds, (3) favours attacks by storage insect pest, (4) increases the chances of damage to seeds by fumigants, and (5) interferes with processing because damp seeds tend to stick together.

Isolation: Seed field shall be isolated from the contaminants shown in the table below:

Contaminants	Minimum distance (meters)			
Field of the other varieties of the same spp.	Foundation		Certified	
	Self-compatible types	Self - incompatible	Self-compatible types	Self - incompatible
Fields of the other varieties of the same spp.	100	200	25	50
Field of the same variety not conform to varietal purity requirements certification	100	200	25	50
Field of Rocket salad and any of other species of the genus *Brassica*	50	100	25	50

Agronomic Management

Sowing

Sowing should be done as per the recommendation of respective states. Normally, sowing of mustard should be done in mid October and of toria during second fortnight of September. Seed drill should be thoroughly cleaned before filling the nucleus/breeder seed in it. Row to row spacing of 45 cm and plant to plant spacing of 15 cm should be maintained. Two meter space after every 25m should be left as path for monitoring, management operations and rouging of off-type plant.

Fertilizer

Recommended dose of N:P:K for mustard are 80:40:30 kg/ha and for toria 50:25:25 k/ha, respectively. Half of the dose of nitrogen and full dose of phosphorus and potash should be applied at sowing and remaining nitrogen should be applied at first irrigation. Application of 25 kg zinc sulphate per hectare gives good response in addition to the normal dose of fertilizer.

Thining and interculture

Thining should be done after 3 weeks of sowing to maintain optimum plant population followed by intercultural operations for controlling the weeds.

Irrigation

The number of irrigations depends on the type of soil. Normally two irrigations are required first at 30-35 days after sowing and second at seed filling stage.

Roguing

The remove/reject off-type plants of the same species at pre-flowering stage. First, the off-type plants distinguishable on the basis of morphological characteristics should be removed before flowering. Second, the off-type plants, which are identified at flowering, should be removed before pod-formation. Third, the off-type plants should be removed on the basis of siliqua and seed characteristics and also on the basis of maturity duration. Disease infected plants should be removed. The field should be kept free from all kinds of weeds particularly from Argimone maxicana (Satyanashi) which should be uprooted altogether before it flowers.

Plant protection measures

Alternaria blight

Alternaria blight appears on the leaves of one month old crops in the month old crop in the form of brown or black spots with concentric rings. The disease may be controlled by the spray of Mancozeb @ 0.2%.

White rust

It appears on the lower side of leaves as white, raised, dry, eruptions. Seed treatment with Metalaxyl (Apron 35 SD) @ 6g/kg seed or Thiram @ 2.5g/kg seed is recommended to prevent the disease occurrence. To control the disease spray of Ridomil MZ 72 W.P. or Mancozeb (Dithane M 45) @ 0.2% at fortnightly interval soon after the disease appearance. (maximum 3 sprays) are recommended.

Sclerotinia stem rot

It is a soil borne disease emerging as an important disease in recent years, it's symptoms appears as water soaked pale or brown lesions at base of stem. The black pellet-like sclerotinia may be formed either internally in the pith of the stem or on the stem surface. The seed should be treated with 0.1% a. i. Carbendazim(Bavistin). Foliar spray of Carbendazim (Bavistin) @ 0.1% at 50 and 70 days after sowing, is recommended to manage the disease. The field, in which this disease has appeared, should not be selected for seed production.

Field Monitoring

The seed production plot should be inspected at different growth stages particularly before flowering, at flowering, and at maturity by a monitoring team including the crop breeders and representatives of State/ National Seed Corporation and State Seed Certification Agency. The reports should be submitted in respect of nucleus/breeder/certified seed production standards and critical comments should be recorded on genetic purity of varietal seed plots. The monitoring report must be produced before the buying agency on demand.

Post Harvest Management

Harvesting and threshing

Border row plants of 2 m area from all sides of plots should first be harvested separately as a not experimental area to maintain genetic purity. The plots should be harvested at the stage when 70-80% plants turn yellow. The harvested crop is staked and dried before threshing. Staking of crop is important to obtain good luster of seed. Threshing may be done either manually or by thresher.

Seed Processing

After threshing, the seed should be dried either in sunshine or in mechanical seed drier to bring the seed moisture down to 8%. The temperature of air in seed drier should not exceed 400C. A random sample from the dried seed is taken and analysed for quality characters and oil content before the grading. The Indian Minimum Seed Certificate Standards recommends the size of screen aperture as given below for seed grading of rapeseed-mustard which vary according to the size of a variety.

Top screen (round): 2.75, 3.00, 3.25

Bottom screen (slotted): 0.90, 1.00, 1.10, 1.40mm.

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VERMI COMPOSTING FOR ORGANIC FARMING: INFLUENCE ON THE SOIL QUALITY & SOIL HEALTH

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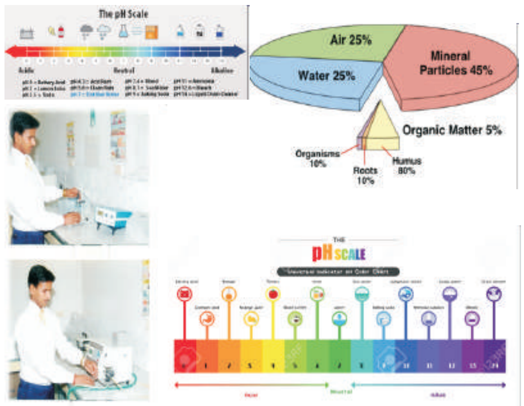
Vermicompost:What is vermicomposting?

Well, it is essentially the decomposition of organic material (cattle dung/ plant residue) by earthworms. Excellent profits can be obtained by commercial production of vermicompost as its use is increasing day by day. Excellent quality of compost can be produced in ambient temperature conditions in a short period of time by using proper species of earthworms (Eisenia foetida). Earthworms promote faster decomposition of organic matter. It plays a very important role in improving growth and yield of different crops like vegetable, flower and fruit crops. Vermicompost, apart from supplying nutrients and growth enhancing hormones to plants,improves soil structure leading to increase in water and nutrient holding capacities of soil.

The major advantage is that it can be used for all crops at its any stage. Its commercial production is increasing due to low investment and high returns than fertilizer companies. In India, it costs about @ Rs. 2/Kg of vermicompost and can be sold at @ Rs. 10-15 Rs/kg in open market. Vermicomposting truly is nature's great disappearing act! Aristotle once said, "Worms are the Intestines of the Earth"

Composition of vermicompost

Nitrogen (N) 1.12-1.64% Phosphorus (P) 0.15 - 0.70% Potash (K) 0.21- 0.80% Calcium (Ca) 1.15- 3.75% Magnesium (Mg) 03-04% Sulpher (S) 10-15 ppm Iron (Fe) 45-50 ppm Manganese (Mn) 60-70 ppm Zinc (Zn) 20-25 ppm	 **C:N ratio** 12:1 **CEC** : >200 **pH** : 7.00-7.5 **SOC** : 15-20

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Vermicomposting in shed

Environment for Earthworms in Compost Material

- A pH range should be between 6.5 to 7. 5 along moisture content of 60-70% below and above range mortality of worms taking place.
- Suitable aeration should be 50% from total pore space.
- Temperature range of 20 to 35℃ is suitable for best production.

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Earthworm beds

Precautions for vermicomposting: The following cautions are recommended in productions of vermicompost.

- Vermicompost beds/heaps are not covered with plastic sheets/material, since this can trap heat and gases.
- Should not overload the vermicompost
- heap to avoid high temperature that adversely affects their population.
- Water stress or dry conditions kill the earthworms. Make sure to water daily in summer and every third day in rainy and winter season to supply continuous moisture to beds.
- Addition of higher quantities of acid rich substances such as citrus wastes should b e avoided.
- Make sure to have a drainage channel around the heap to avoid stagnation of water particularly in high rainfall areas in rainy season.
- Use organic materials in composting which are free from materials such as stones, glass pieces, plastics, ceramic tubes.
- No specific diseases found in vermicompost preparation. However, ants, termites, centipedes, rats, pigs and birds are main predators. To prevent these, treat the location/site with 5% Neem based insecticide before filling the heap.

Eisenia foetida

Eudrilus eugeniae

Perionyx excavatus

Methods of vermicompost production

Pit method: Pit method is commonly used for small scale production of vermicompost. These steps can be followed

➢ Construct a pit of 3×2×1 m size (L×W×D) over ground surface using bricks. Size of p i t may vary as per availability of raw materials

➢ Fill the pit with following four layers:

- 1st layer – sand or sandy soil of 5-6 cm. This layer helps to drain excess water from the pit.
- 2nd layer - paddy straw or other crop residue of 30 cm above 1st layer which will be used for providing aeration to the pit.
- 3rd layer - 10 to 15 days old cattle dung over paddy straw layer at a thickness of 20-30 cm. This helps in initiating microbial activity.
- 4th layer - pre-digested material about 50 cm

➢ Inoculate earthworm @ 1000 worms per square meter area or 10 kg earthworm in 100 kg of organic matter.

➢ Spray water on the bed and cover it by gunny bag. Maintain 50-60% moisture of the pit by periodical water spraying.

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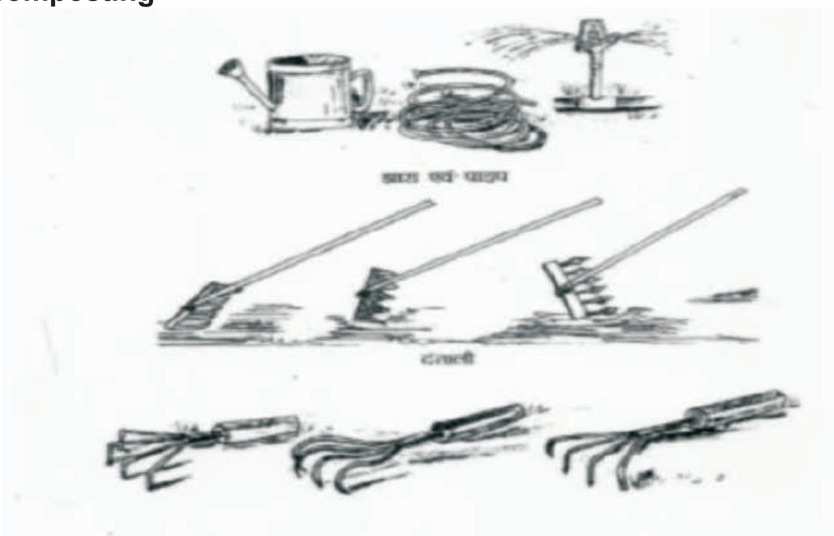
Bed method

- Construct a bed of 3 x 1 x 1 m size (L x W x D) over ground surface using bricks. Length of bed may vary as per availability of raw materials
- Place the organic material like cattle dung and farm waste in layers to make about 0.6 to 1.0 meter height.

Earthworms should be introduced in between layers @750 to 1000 worms per meter cube (1 cubic meter) of bed volume that weighs nearly 1 kg. The beds should maintained at about 50-60% moisture content and a temperature of 20-30 ℃ by sprinkling water over beds.

Tools for vermicomposting



Harvesting method of vermicompost: The following steps should be taken for harvesting the vermicompost.

- Stop watering before one week of harvest.
- Sometimes the worms spread across the bed/pit come in close and penetrate each other in form of ball in 2 or 3 locations.
- Heap the compost by removing the balls and place them in a bucket. Top layer has to be disturbed manually. Earthworms move downward and compost separated. After collection of

compost from top layers, feed material is again replenished and composting process is rescheduled. The material is sieved in 2 mm sieve,the material passed through the sieve is called vermicompost which is stored in polythene bags.

- Re-composting can be done in the same pit or bed. Similar to the above described pit/heap method.
- Vermicompost can be prepared in wooden box or brick column in similar way.
- In-situ vermicomposting can be done by direct field application of vermicompost @5 tones/hectare followed by application of cattle dung (2.5-3.0 cm thick layer) and then a layer of available farm waste about 15cm thick. Irrigation should be done at an interval of 2 weeks.

Application of vermicompost in various crops: Though it can be applied at any stage, mixing in soil after broadcasting fetch more benefits.

- Usually any field crops require 5-7 tones/ha.
- Any vegetable crop requires 10-12 tones/ha.
- Any flower plants require 100-250 grams/square feet.
- Any fruit trees require 5-10 kg/tree.

Advantages and Benefits of Vermicompost: The following are advantages of vermicompost used in various crops:

- Vermicompost is rich in all essential plant nutrients and provides excellent plant growth and encourages the growth of new leaves and improves quality and shelf life on the produce.
- Vermicompost is free flowing, easy to handle and store and doesn't have any foul order.
- Vermicompost improves soil structure, texture, aeration, and water-holding capacity and prevents soil from erosion.
- Vermicompost harbors certain microbial populations that help in Nitrogen fixation in soil and P solubilization.
- Vermicompost prevents nutrient losses and increases use efficiency of chemical fertilizers.
- Vermicompost is free from activity of earthworms in soil, soil pathogens, and weeds.
- Vermicompost minimizes the incidence of pest and diseases in growing crops/trees/ plants.

- Vermicompost enhances the process of decomposition of organic matter in soil.
- Percentage of N: P: K content is more in vermicompost when compared to traditional or bacterial compost.
- Organically grown crop are believed to provide more healthy and nationally superior food for man and animals that those grown with commercial fertilizers.
- Organic farming helps to avoid chain reaction in the environment for chemical spray and dusts.
- Organic farming helps to prevent environment degradation and can be used to regenerate degraded areas.
- Since the basic aim is diversification of crops, much more secure income can be obtained that when they reply on only one crop or enterprise.
- Organic manures produce optimal condition in the soil for high yields and good quality crops.
- Vermicompost supply the entire nutrient required by the plant (NPK, secondary & micronutrients).
- Vermicompost improve plant growth and physiological activities of plants.
- Vermicompost reduce the need for purchased inputs.
- Most of the organic manures are wastes of byproduct which accumulated load to pollution.

✓ So let's join for three R's of Recycling Reduce, Reuse, Recycle, i.e. certificate course in vermicompost technology.

Example: Detail of expenditure budget for establishment of Vermi compost Unit
If investment Rs 3000 we will got

✓ After 45 days production of vermicompost and earthworms

1. 10Q vermi compost @ Rs. 20/Kg

S. No.	Particulars	Amount (Rs.)
1	Cattle dung @ Rs.1500/20 Q	1500.00
2	Labour cost Part time labour	1000.00
3	Others	500.00
	Total Rs.	3000.00

2. 50 Kg Earth worms @ Rs. 300/Kg

Net benefit Income – investment cost =
Rs. 10 X 2000 = 20,000.00
50 X 300 = 15000.00
Total income Rs 35,000.00
Net income = Rs. 35,000.00 -3000.00
= Rs. 32000.00 per 45 days

Extension activities

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SOYBEAN FOR HEALTH AND NUTRITIONAL SECURITY IN INDIA: A FEW CONSIDERATIONS

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Introduction

Soybean (Glycine max L. Merril) is one of the most important dual purpose crops which is used not only for edible oil but for plant origin protein as well. It contains 18-20% oil and 38-45% protein. It contributes nearly 25% to the world's edible oil pool. For centuries, soybean has been in use in various forms including milk, tofu, edamame or vegetable, grain or in various fermented forms in the East and South East Asian countries viz., China, Japan, Korea, the Philippines, and Indonesia. Hence, people in these countries dearly called soybean as 'farm cow'. Soybean is an important feed component for the animal, poultry and fishes. It has numerous applications in the pharmaceutical, cosmetic and other product industries as well. It acts as a 'tonic' to the soil as it enriches the field with atmospheric Nitrogen by symbiotic fixing with Rhizobium bacteria. Considering multifarious application and utility, soybean is popularly called as 'miracle bean'.

Soybean production and consumption

Commercial cultivation of soybean in India started during 1970s in about 30,000 ha only. Now, within about 50 years, its area has crossed 11 million ha (mha) reflecting its popularity among the farmers of the country. Leaving far behind peanut and rapeseed and mustard, currently, soybean is the numero uno oil seed crop in India. It is grown in about 11 mha area with annual production of around 10-12 million ton (mt). Accordingly, India ranks fifth in the world in terms of area and production (Table 1); however, productivity (1.0 ton/ha) still is a point of concern as it is far less than world average (2.5 ton/ha).

In India, soybean is primarily grown in the central part of the country. The major soybean growing states are Madhya Pradesh, Maharashtra, Rajasthan, Karnataka, etc.

Table 1. Production (million metric tons) status of soybean in different countries across the world

Year	USA	Brazil	Argentina	China	India	Others	Total
2015-2016	106.869	96.500	58.800	12.367	6.929	35.107	316.572
2016-2017	116.931	114.600	55.000	13.596	10.992	39.415	350.534
2017-2018	120.065	122.000	37.800	15.283	8.350	38.110	341.608
2018-2019	120.515	117.000	55.300	15.900	10.930	38.564	358.209
2019-2020	96.615	123.000	53.000	17.100	9.000	37.848	336.563

Source: Oilseeds - World Markets and Trade, a USDA Publication

(www.dacnet.nic.in). Area, production and productivity of soybean in some states of India are presented in Table 2. It shows that lion's share of soybean cultivation area and production in India is taken by the state Madhya Pradesh, which is also called as 'Soya State'. In India, 75-80% of the soybean is primarily used for oil extraction, about 10% is used as seed and rests (10-15%) are used as direct food such as soybean nuggets, soy milk, soy-paneer (tofu), soy sauce, roasted soy, soy cookies, etc. Of late, because of health benefits, soybean and its various products are getting special attention from the consumers'. Similarly, owing to population growth and increase in purchasing power, demand for edible oil is also increasing. Per capita demand of vegetable oil by 2020 is estimated to be 16.38kg/year as against 4.0kg/year in 1961. Nearly 50% of such demand is met by import for which the country spends a huge amount of money. It surely highlights the urgent need of increasing production of oilseed crops in the country. Soybean, which contributes nearly 40% to the oilseed production of the country, is certainly a strong candidate asking for immediate attention towards expansion of its area, production and productivity.

Table 2. Area, production and productivity of soybean in India during kharif 2019

Sl. No.	Name of the state	Area (lakh ha)	Production (lakh mt)	Yield (kg/ha)
1	Rajasthan	9.627	6.560	681
2	Madhya Pradesh	51.952	40.107	772
3	Maharashtra	37.365	39.415	1055
4	Andhra Pradesh	1.783	1.508	846
5	Chhattisgarh	0.742	0.539	726
6	Gujarat	1.003	0.861	858
7	Karnataka	3.302	2.694	816
8	Others	1.841	1.377	748
	Grand Total	107.615	93.061	865

Source: SOPA Databank

Composition and health benefits

Soybean oil is considered to be good for health as it contains lesser saturated fats and more unsaturated fats. In general, per 100g soybean oil contains 16g of saturated fatty acid (SFA), 23g of monounsaturated fatty acid (MUFA), and 58g of polyunsaturated fatty acid (PUFA). The SFA includes palmitic acid (C-16:0) (~10%) and stearic acid (C-18:0) (~4%). The major unsaturated fatty acids found in soybean oil includes mono-unsaturated oleic acid (C-18:1) (23%), polyunsaturated linoleic acid (C-18:2) (51%), and linolenic acid (C-18:3) (7-10%). Thus, Omega-6 polyunsaturated fats are the predominant fats in soybean seeds. Similarly, soybean is the richest source of protein that contains optimum dietary essential amino acids profile for human health and animal nutrition. As it contains no starch, soybean is considered to be a good source of protein for diabetics. Soybean also contains bioactive proteins viz., lectin and lunasin, which are reported to have anti-cancer activity. Popularization of soybean as food can reduce protein and energy malnutrition (PEM) prevailing in the country.

Soybean seed also contains a wealth of nutrients and vitamins viz., vitamin K, B6, riboflavin, thiamin, folate and vitamin C. The mineral includes iron, zinc, phosphorus, copper, potassium, magnesium, manganese and

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calcium. It is also a rich source of organic compounds and antioxidants such as tocopherol, which act as free radical quenchers preventing lipid peroxidation in the soybean oil and its products. Soybean also contain higher amount of isoflavones that performs several important body functions.

The wonderful composition of various elements and organic compounds has made soybean a healthy food. It has the ability to improve digestion and metabolism leading to healthy growth. It can also maintain the health of heart, bones, defend against cancer, birth defects, reduce the ill-effects of menopause, increase blood circulation, decrease the risk of diabetes, and tones up the body.

Genetic improvement initiatives

Considering importance of the crop, Govt. of India initiated effective steps to popularize the crop and boost its production and consumption. Way back in 1967, Indian Council of Agricultural Research (ICAR), New Delhi organized nationwide research and genetic improvement of soybean through All Indian Coordinated Research Project (AICRP) on soybean. It also established one national institute dedicated exclusive for soybean research i.e. Indian Institute of Soybean Research in Indore (MP), the heartland of soybean cultivation. As a consequence of sincere effort and relentless thrust through the nationwide network of soybean research and extension, soybean cultivation has expanded beyond 10 million ha area. Till now, more than 110 soybean varieties with higher yield and specific qualities have been released for commercial cultivation in the country. Consequently, the annual production of soybean has also increased by several folds to about 11-12mt. However, productivity of soybean remains a concern as it is hovering around 1.0ton/ha as against the world average of about 2.5t/ha. Reasons for low productivity are many; to list a few are as follows: rainfed cultivation, damage caused by biotic and abiotic factors, improper management, poor mechanization, shortage of good quality seeds in time, etc. In spite of these constraints, soybean production in India is increasing substantially. It is replacing areas of other competitive crops such as cotton in certain pockets in the country. Further, it can be expanded to cultivate in the non-conventional areas with assured irrigation and better management facilities to boost production and productivity.

A few considerations

Considering deteriorating soil health and depletion of natural resources, it has been suggested to replace rice in a few North Indian states with other crops. Rice takes longer time and utilizes more water for its growth and development. Being kharif crop, soybean can be an appropriate alternative to rice. Soybean takes lesser time and consumes lesser water than rice. In a normal monsoon year with sufficient rainfall, 3-4 irrigation should be sufficient for growing soybean. Further, soybean makes soil fertile through fixation of atmospheric Nitrogen. Replacing rice with soybean will reduce air pollution caused by burning of rice residues. However, to make it acceptable to the farmers, the soybean varieties should be highly productive and its cost-benefit ratio should be comparable to rice. To motivate the farmers, Government may offer some incentives to the farmers so that they prefer soybean or such other crops in place of rice. Government of Haryana has already announced and implemented such initiative for popularizing maize in place of non-Basmati rice. Such effort in large scale is expected to have ever lasting effect in the soil health and environment of the country.

Soybean is a highly nutritious crop. It is the richest source of vegetable protein. The de-oiled cakes of soybean are also highly nutritious. It is primarily exported as feed to earn foreign currency. Contrarily, a large chunk of our population, women and children in particular, are suffering from protein-energy malnutrition. A few initiatives such as conversion of de-oiled cake to edible food products, making soy-based foods available in the mid-day meal of the schools across the country, supplying soybean through public distribution system (PDS), etc. could address the problem of protein malnutrition rampant in our country. De-oiled cakes have also been reported to be beneficial to the poultry and fishes. However, there is lack of awareness about soybean and its utilities. Therefore, it is essential to create awareness about it and make the food and feed available in the market for larger benefit of the country.

Soybean seeds contain Kunitz trypsin inhibitor (KTI), an anti-nutritional factor, which limits large scale consumption of soybean in its un-processed forms. Processing industries eliminates KTI through heat treatment incurring extra costs. Similarly, presence of lipoxygenase in the seeds produces a characteristic flavor usually not preferred by the consumers'. Phytic acid contents in the soybean seed hampers bioavailability of iron and zinc in the food. Effective breeding approaches are needed to make soybean seeds free from these undesirable chemicals and make it popular among the soybean consumers. Reports of satisfactory progress of scientific endeavors in this direction are available.

A large section of Indian population is vegetarian. Grain legumes including soybean are the important source of protein for them. Along with soy foods and soy-based products, vegetable soybean or edamame can supplement protein requirement of the vegetarian people to a large extent. However, vegetable soybean is still not getting popular due to lack of awareness as well as taste of the beans. Efforts are needed not only to increase yield of vegetable soybean but also to increase its taste and flavor to satisfy the taste buds of the consumers.

Conclusion

Although originated in China, soybean has now become a world crop. It is an important oilseed crop as well as valuable source of protein, mineral, vitamins, etc. Beyond food and feed, numerous application of soybean in the cosmetic and pharmaceutical industries has made it be the 'king bean'. India holds promise for further improvement of this wonderful crop. Concerted effort is required to increase its production and productivity and to make it a household food for health and nutritional security of the consumers.

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INNOVATIVE TECHNOLOGIES TO BOOST INDIAN PRODUCTIVITY IN AGRICULTURE

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India agriculture has been characterized by many revolutions that changed the very face of this sector. The green revolution, blue revolution, yellow revolution and white revolution have been the important milestones in Indian agriculture. One thing common in all these revolutions was the use of technology. The revolutions could not have occurred without relevant technologies. The technological led agricultural development saw India emerging as world leader in many important food commodities. Our food production which was merely 50 million tonnes at the time of independence has now reached more than 250 million tonnes. Similarly in case of livestock, we are the leading producers of the milk in the world and the largest producers of pulses.

While more than sixty percent of the population depends on the agricultural sector, yet the sector also carries the blot of farmers' suicides, high food inflation, the low yields, the climate threat and the still presence of a considerable population in the grip of below poverty line category. This is also happening at a time when we have to achieve the Millennium Development Goals in the near future. Food production has to be increased in the context of worsening land and water scarcity and climate-change-related weather shocks. The problems in agriculture are not confined to a particular territorial jurisdiction. Some of them have now become universal. Land degradation is also another important factor affecting productivity. This is despite large investments in yield-enhancing varieties. An IFPRI reports that soil compaction alone has caused yield reduction of between 40-90 per cent in western African countries, and nutrient depletion also reduces productivity in Sub-Saharan Africa (SSA) and South Asia. Meanwhile, twenty African countries are already experiencing severe water scarcity and another 12 will face water scarcity over the next 25 years. Land degradation is worse in areas where poverty and hunger are concentrated. Further the climate change disproportionably affects smallholders as they are more likely to depend on rainfed agriculture and degraded land. All this demands renewed and vigorous efforts towards technologies for agricultural development. Broadly the different types of technologies for furthering agricultural development are as:

Resource conserving technologies:

Resources are an important asset for a country. Unfortunately the non judicious use of these has put them in very critical situation. The indiscriminate use of chemicals for increasing productivity and disease controls have polluted water bodies and degraded soils. What is worrying is that there is a gender specific effect to the resource degradation. It is increasing the time required for fulfillment of female responsibilities such as food production, fuel wood collection and soil and water conservation. An array of resource conservation technologies is available. These include zero and reduced tillage. green manuring, crop rotations etc. Resource conservation technologies aim to produce more at less cost while at the same time enhancing the natural resource base and maintenance of soil quality in fairly good conditions. The input use efficiency also gets increased due to the right placement of the seeds and fertilizers at right time and at right depth. Some of the resource conservation practices areas:

· Reduction of tillage and retention of adequate surface crop residues over the soil. Zero Tillage in wheat has reported to reduce the production costs by 2000 to 2500 per hectare and 15-20 per cent saving in irrigation water. No till wheat is also more tolerant to abrupt climate changes.

· Similarly by using drip and sprinkler type of irrigation methods the more area can be brought under irrigation than the conventional irrigation methods by canals.

· The use of Farm Yard Manure (FYM), Compost, and Bio fertilizers also reduce over dependence on the chemicals led intensive cultivation. These also are beneficial for soil health, soil micro organisms and soil fertility in the long run.

· Promoting diversification of agriculture with subsidiary occupations also lead to enhancement of farm incomes and reduction of risks in case of failure of one of the components.

High yielding technologies:

The green evolution of the sixties would not have occurred without the High Yielding Varieties of Wheat and Paddy. These high yielding varieties along with increased area under irrigation fertilizers saw India becoming a bread basket from once being leveled as a begging bowl. Unfortunately, presently also our yields are less comparative to the yields of crops in other countries. This has severely reduced our total production. If Indian agriculture is to remain in competition with the global agriculture it has to increase the per unit yield of its crops. This requires the development and production of seeds which have more yields, are resistant to diseases, are not susceptible to insect pest attack, and can withstand the environmental extremities Sustainable intensification of agriculture is a good alternative to avoid localized chronic food and nutrition insecurity when between 75 and 90 per cent of staple foods are produced and consumed locally. System of Rice Intensification (SRI) has emerged as an alternative to the conventional rice growing methods. SRI uses less water, is more efficient in using available water and considerable higher yields are achieved by this method. Unleashing the full potential of smallholders, including that of women farmers, is thus key to global food and nutrition security, creation of decent work, and sustainable agriculture.

Post harvest technologies:

Post harvest infrastructure also plays an important role in Indian agriculture. A considerable proportion of our produce goes wasted in the absence of suitable post harvest infrastructure. A study puts this losses to the tune of rupees 44,000 crore. This can be avoided if suitable post harvest infrastructure is provided to the farmers. As most of the horticultural produce is perishable therefore immediate handling of the produce after harvest is necessary. Suitable post harvest infrastructure in terms of cold storages, processing units, road networks in inaccessible areas, establishment of local regulated markets at the Panchayat levels can give a big boost to the agriculture sector by promoting value addition and food processing. This can also help in creating employment opportunities for the others also.

Crop genetics & pest management.

Like livestock breeding, the idea of improving plant genetics is not new. Farmers and scientists have used plant selection and breeding techniques to improve crop yield for years. Plant breeders have worked to improve germplasm to develop seeds with the best mix of characteristics to deliver the best yield for specific soil and weather conditions.today, plant breeders use a mix of both traditional and modern methods to improve plants. Modern breeding methods include marker assisted breeding, which helps speed up the time it takes to to get the desired improvement, and genetic engineering (GE). GE technology can improve a plant's insect resistance, drought tolerance, herbicide tolerance, and disease resistance. This technology gives farmers and additional tool to help increase crop yields.

Climate resilient technologies:

The effects of Climate change are being witnessed all over the globe but the vulnerability of Indian agriculture to this is high. This is because a large population is dependent on agriculture and also we lack suitable coping mechanisim. Already negative effects of the rising temperatures have been reported in many food crops and the situation can get further aggravated. In India agriculture is mostly in rainfed areas therefore climate resilient technologies are the need of the hour. In the country a project entitled 'National Initiative on Climate resilient Agriculture' has been going on. This aims to enhance resilience of Indian agriculture to climate change and climate variability through strategic research and technology demonstrations in most vulnerable districts of India. The basic purpose is to enable the farmers to cope up with the climatic variability through efficient management of their resources.

Artificial Intelligence

The development and deployment of AI in agriculture are on the increase due to the availability of the precision data. AI-based modern and high-tech tools can help get precision to large-scale agriculture. Farm equipment can plant different densities of seeds and apply different amounts of fertilizer in different parts of a field. While AI has become a mainstay of the tech community, many of the major agriculture input companies, equipment manufacturers, and service providers have yet to vigorously pursue AI applications in agriculture. Prediction of advisories for sowing, pest control, spray pesticides, irrigating and commodity pricing can help increase productivity and income of the Indian agriculturists. Using remote sensing and GIS applications effective agricultural exhibition is possible to keep an eye on.

Technologies for drudgery reduction:

Agriculture in India is prone to drudgery and women that constitute half of the work force in agriculture are more susceptible to this. Mechanization is also another important aspect for enhancing agricultural production. Unfortunately mechanization is very low in India. Farmers still operate with their traditional implements which hamper their performance. Women which constitute an important partners in this sector are still not been recognized properly. A study done in Orissa under the Project, 'Standardization of women specific field practices in rice in Orissa' revealed that women of family contributed highest hours per season in harvesting and post harvest operations (61.66).

But their condition still is deplorable deep down in the drudgery. Women do most of the operations right from the harvesting to winnowing, grading and storage. FAO estimates that giving women better access to land, inputs, and technology could increase yield by 2.5-4 per cent and reduce undernourishment by 12-17 percent. Improved farm tools and implements for reducing drudgery reduction are the need of the day. Our research efforts should also focus on relieving the women of this drudgery by developing appropriate tools that could reduce drudgery of the women engaged in this sector. The Central Institute of Agricultural Engineering, Bhopal has developed tools such as the seed drill, seed broadcaster, seed treatment drum, hand ridges and dibblers. The marginal and small farmers despite being the major producers of food, especially in developing regions, are the majority of the world's poor people still outside the ambit of technologies and a very large proportion of the chronically undernourished. Agriculture which is not specific to growing of food crops but also includes livestock, apiculture, pisiculture, apiary, goatry forestry etc has to undergo a significant transformation in order to meet the above related challenges. This new agriculture paradigm must ensure that the small and marginal farmers be at the center stage of any technological interventions. Boosting agriculture productivity, in particular of smallholders, is one of the most effective ways of addressing global poverty and food and nutrition security. Output growth in agriculture is more effective in reducing than poverty than the same growth emanating from other sectors. What is needed is that the appropriate technological interventions be provided to the farming community according to their agro climatic condition. .

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SUGAR FREE, AROMATIC AND NUTRITIOUS RICE VARIETY KALANAMAK KIRAN NOTIFIED IN 2019

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Introduction:

Kalanamak rice is an epitome of best aromatic rice cultivated and consumed in Northeastern part of Uttar Pradesh (U. P.). To the local palate, it was preferred, even classed superior to Indian mystery rice Basmati. Kalanamak variety of rice has been under cultivation since time immemorial. Exact history of its cultivation is not recorded but it is believed that Kalanamak was a preferred variety for offerings given to Lord Buddha some three thousand years ago (Chaudhary and Tran, 2001). Lord Buddha himself has given the seed of Kalanamak to people of Bajaha Jungle (now Bajaha village) in Siddharth Nagar district, ever since it has been under cultivation (Chaudhary, 2016). Kalanamak has been in cultivation mainly in north-eastern part of Uttar Pradesh and western and central part of Nepal Tarai.

However, over centuries of cultivation and farmers' way of handling seed, neglect by rice research institutions and double onslaught on economic front by High Yielding Varieties (HYV), its area went down from 50,000 ha to 2,000 ha. Grain quality deterioration and loss of aroma was noticed due to a gamut of reasons starting from spontaneous mutation and out-crossing resulting into mixtures of aromatic and non-aromatic types, non-scientific seed production, altered cultivation practices, change of environment and lack of any improved variety. However, by continued researches (Chaudhary, 2009), funded by U. P. Council of Agricultural Research (UPCAR) during 2001 to 2008, support from Tata Trusts and Department of Agriculture under Paramparagat Krishi Vikas Yojna (PKVY), done at Participatory Rural Development Foundation (PRDF) technologies were developed to save Kalanamak to bring its old glory back. Out of the exhaustive germplasm collections of Kalanamak, U. P. State Variety Release Committee released in 2007 and Government of India notified it as KN3 in 2010.

Other varieties of Kalanamak rice: KN3 was tall and low yielding (22-25 qtl/ha.) and that nictitated development of semi dwarf varieties like Bauna Kalanamak 101 in 2016 and Bauna Kalanamak 102 in 2017 which has yield potential of 40-45 qtl/ha. However, there were problem with the husk colour, awn and grain quality. That necessitated the development of current Kalanamak Kiran, described in this article.

Morpho-agronomic Characters of Kalanamak Kiran:- Kalanamak Kiran is strongly photo-period sensitive variety with short basic vegetative phase. It flowers around 20th of October irrespective of its sowing date between 15th May to 1st week of July. Detail morpho-agronomic characters are given in Table 1. It has resistance to major pest and diseases (Table 2). It has black husk, excellent aroma about 20% amylose to make cooked rice soft on the palate, high protein (10.4%) and low Glycemic Index to make it sugar free and suitable even for diabetic patent.

Cultivation practice:

Time of cultivation:- Kalanamak should be cultivated only during Kharif season to maintain its grain quality. Ideal time of its nursery sowing is last week of June to first week of July. Details of the cultivation practices were published by Chaudhary et al.)2008). Once the seedlings

have attained the age of about 30 days, these are ready for transplanting. Ideal time for transplanting is last week of July to first week of August. Transplanting should never be done before last week of July. Since it is a highly photo period sensitive variety even if it is seeded in May or early June, it will still flower around 20th October. It is responsive to higher doses of fertilizer but considering the economics, 120 kg of nitrogen, and 60 kg of Phosphorus and potash is recommended for one hectare for best economic yield.Before its release and notification, Kalanamak Kiran was tested at the Regional Agricultural Testing and Demonstration Stations (RATDS) for 3 years. In these trials, Kalanamak Kiran has sown its superiority over the check varieties KN3 and Lalmati. It was also tested in All India Trials at 28 locations where it maintained its superiority for yield and grain quality characters.

Seed rate:- Due to small grain size, lower 1,000 grain weight, and excellent tillering ability, 30 kilograms seed of Kalanamak is enough to cultivate one hectare of land.

Nursery management:- The best time of nursery sowing is last week of June to the first week of July. For raising nursery of Kalanamak, wet seedbed method of raising the nursery is recommended. To cultivate one hectare of Kalanamak, 0.1 hectare i.e. 1,000 square meters of nursery area is needed.

To prepare seedbed for one hectare field, plough and bund 1,000 square meters of field. Apply about 500 Kilogram of farm yard manure (FYM) and mix it well in the soil. Avoid using fertilizer to get better quality of the produce. In case FYM is not available, only then apply 8 Kilogram of Nitrogen, 5 Kilogram of Phosphorus and Potash. If the soil is known to be Zinc deficient, apply 3.5 Kilogram of Zinc Sulphate during land preparation. Make 1.5 meter long strips leaving 0.5 meter gap between the two strips for cultural operations. After mixing the FYM well in the soil, fill the bed with water, puddle and level it well so that about 2 centimetres of water stagnates in the seedbed. Then broadcast the sprouted seed before the mud settles down.

Preparation of main field:- While the nursery is growing, preparation of main field must begin to prepare good tilth and also to kill the growing weeds. In order to avoid use of inorganic fertilizers, use FYM, and green manure. If green manure is to be applied, Sesbania (Dhaincha) or Crotolaria juncea (sunhemp) or Mung should be sown in the mid May to first week of June either with the onset of rains or by irrigation. Once these crops have grown for about 40 - 45 days, these should be ploughed in the field using mould board plough. In case Mung was grown the pods should be hand picked before ploughing in the field. It may be noted the field must be full with 20 cm water to allow proper rotting. This will allow a proper decomposition within a week. Such green manuring provides at least 80 Kilogram of Nitrogen per ha.

In case green manuring is not possible 6 – 10 tonnes of FYM or compost should be applied before ploughing. If green manuring has been done, amount of FYM may be reduced to half. It has also been found by experienced farmers that application of 2 quintals of Neem cake is useful not only to supply the Nitrogen but also to reduce the incidence of pests and diseases.

In case neither green manuring nor FYM or compost is available, the fertilizer dose of 60 Kilogram of Nitrogen, 30 Kilogram Phosphorus and 30 Kilogram potash should be used per ha. Preferred source of Nitrogen should be Urea or Ammonium Sulphate or DAP. If the soil has a history of Zinc deficiency, 25 Kilogram Zinc Sulphate should be applied per ha before transplanting. Final land preparation should be done after filling the field with 4 to 5 cm of water and puddling with any appropriate tractor or bullock drawn puddler or equipment. Perfect levelling of field should be done for better water management, weed control and fertilizer efficiency. Apply half quantity of Nitrogen and full quantity of Phosphorous and Potash during the final puddling i.e. before transplanting.

Transplanting:- A spacing of 20 cm row to row and 15 cm plant to plant is recommended. Once seedlings have attained age of 20 - 30 days, these are ready for transplanting. Seedling should be uprooted taking maximum care not to break the root or cut the leaf. Once the seedlings have been pulled out they should be transplanted immediately or on the same day. Two to three

seedlings should be transplanted at one place (hill).

Fertilizer management:- There are number of ways, methods and combination to supply major nutrients to the plant. A combination of green manure, compost, FYM, and cakes can be devised to supply required nutrition to Kalanamak. This is the most desirable way to get best grain quality and reasonable yield of Kalanamak. Full fertilizer requirement of Kalanamak may be provided totally by inorganic fertilizers like Urea, Ammonium Sulphate, DAP and Super Phosphate but grain quality will be affected though not the yield. In case only inorganic manures are used, 30 Kilogram of Nitrogen, 30 Kilogram of Phosphorus and 30 Kilogram of Potash i.e. half dose of Nitrogen and full dose of Phosphorus and Potash must be applied before transplanting preferably during the final puddling. 15 Kilograms of Nitrogen should be top dressed one month after transplanting. The remaining 15 kg of Nitrogen should be applied at the time of panicle initiation which may be around mid to last week September. As for as possible, water may be drained out of the field before topdressing. After 24 hours after topdressing, water may be reintroduced in the field. This practice avoids losses of applied Nitrogen by way of leaching and also volatilization.

Weed control:- Since transplanting of Kalanamak is done late, by that time most of the weeds in the rice field germinate already. Most of these weeds get eliminated during land preparation including puddling. However within a fortnight weed seeds which have surfaced during land preparation germinate and pose a problem. Therefore, the first weeding needs to be done within a fortnight of transplanting followed by the second one after a month. No weeding is needed afterwards as Kalanamak being a tall variety covers the soil surface suppressing any weed growth. If needed herbicides may be used with caution and consideration.

Pest and disease management:- Kalanamak is cultivated at relatively lower fertility levels. Moreover, it has moderate degree of resistance against major pests and diseases (table 2). But it may get infested with stem borer and gundhi bug. Against stem borer no simple remedy can be recommended. But to control gundhi bug BHC or Malathion dusts may be used during heading to milk formation stage.

Harvesting, threshing and storage:- Usually crop matures within 30 days after full heading. However, date of harvesting may be decided once the leaves have almost dried. Husk being black in colour does not turn golden or straw colour, thus leaves are better indicator of maturity. Threshing should be done immediately after harvesting. Grain should be sun dried to a moisture level of about 12% before it is stored.

Grain quality:- Kalanamak Kiran has medium cylinder grain with black husk and white rice (table 5). It is highly aromatic and soft cooking type with low amylose content. Kalanamak Kiran has also high protein, zinc and iron (Table 3). The significant point is that it has low Glycemic index (53.1%) which is suitable even for diabetic people (Table 3). This heritage rice is full of nutritive vakues (Chaudhary, 2016 and Chaudhary et al. 2012).

Tripling the income:- Current minimum support price of rice is Rs. 1835/qtl, announced by the government. Current selling price of Kalanamak Kiran is between Rs. 3,500 – Rs. 4,000/qtl. Through this price difference, farmer can double their income and triple it of produce organically certified Kalanamak (Chaudhary, 2013, Chaudhary and Mishra, 2012).

Summary:

Kalanamak Kiran has been the best aromatic rice of North-Eastern U. P. in cultivation. Kalanamak Kiran is released by the central variety recommendation and notification committee of govt. of India in 2019. It has excellent aroma very high in zinc, iron and protein. It has of Glycemic Index of 53.1 making it suitable for consumption even by diabetic paten. Summarily, Kalanamak Kiran has the best combination of the grain quality and yield and it can stabilise it from extinction to distinction (Chaudhary e al. 2012). Therefore, farmers can not only double but triple their income. It seed are available with PRDF in Gorakhpur.

Table 1. Distinguishing characters of 4 varieties of Kalanamak (KN 3, Bauna Kalanamak 101, Bauna Kalanamak 102and Kalanamak Kiran.

S.N.	Character \ Variety	Kalanamak KN 3	Kalanamak Kiran
1	Notification by CSCNRV	2010	2019
2	Gazette No.	Gazette No. SO2137-E dated 31.08.2010	Gazette of India No. 3220 (Part II (3) dated 06.08.2019
3	Notification by CSCNRV*	57th meeting* No. SO.2137 (E); Gazette of India No. 1816 (Part II (3) dated 31.08.2010	82nd meeting* notification No. 3-71/2019-SD IV
4	Breeding method	Pureline selection	Hybridisation & Pedigree selection
5	Parentage	Acc. PRDF - KN3 Siddharth Nagar	KN3 x Swarna Sub_1
6	IC Number	IC-551884	IC-618718
7	Leaf sheath colour	Green	Green
8	Maturity (days)	145 (Photoperiod sensitive)	135 (Photoperiod sensitive)
9	Culm length	111 cm. (stiff)	60 cm. (stiff)
10	Plant height	142 cm.	95 cm.
11	Panicle length	31 cm, lax	35 cm, compact
12	Grains / panicle	300	400
13	Awning	Absent	Absent
14	Yield (q/ha)	25	50

*** The Central Sub-Committee on Crop Standards, Notification and Release of Varieties for Agricultural Crops (CSCSNRV)**

Table 2. Resistance of Kalanamak Kiran to major diseases and insect-pests of rice

S.N.	Character \ Variety	KN 3	Bauna Kalanamak 102	Kalanamak Kiran
1	Bacterial Blight	Mod. Susceptible	Mod. Resistant	Mod. Resistant
2	Sheath Blight	Mod. Resistant	Mod. Susceptible	Mod. Susceptible
3	Bacterial Leaf Streak	Resistant	Resistant	Resistant
4	Blast	Mod. Resistant	Mod. Resistant	Mod. Resistant
5	Brown Spot	Resistant	Resistant	Resistant
6	Tungro	Resistant	Resistant	Resistant
7	Stem Borer	Mod. Susceptible	Mod. Susceptible	Mod. Susceptible
8	Brown Plant hopper	Mod. Resistant	Mod. Resistant	Mod. Resistant
9	Green Leaf Hopper	Mod. Resistant	Mod. Resistant	Mod. Resistant
10	Leaf Folder	Mod. Resistant	Mod. Resistant	Mod. Resistant
11	Case Worm	Mod. Resistant	Mod. Resistant	Mod. Resistant
12	Root Weevil	Resistant	Resistant	Resistant
13	Gandhi Bug	Susceptible	Susceptible	Susceptible
14	Green Leaf Hopper	Mod. Resistant	Mod. Resistant	Mod. Resistant

Table 3. Morphological and grain quality characters of grains of Kalanamak Kiran

S.N.	Character\Variety	KN 3	Bauna Kalanamak 102	Kalanamak Kiran
1	1,000 grain weight	15 grams	16 grams	15 grams
2	Aroma (scent)	Highly scented	Highly scented	Highly scented
3	Husk colour	Purplish Black	Purplish Black Brown	Purplish Black
4	Kernel length	5.76 mm	5.76 mm	5.76 mm
5	Kernel width	2.18 mm	2.18 mm	2.18 mm
6	L/B Ratio	2.64 mm	2.64 mm	2.64 mm
7	Grain type	Medium slender	Medium slender	Medium slender
8	Kernel colour	White	White	White
9	Hulling	80 %	80 %	80 %
10	Milling	75 %	75 %	75 %
11	Head rice	70 %	70 %	70 %
12	Alkali value	6 - 7	6 - 7	6 - 7
13	Volume Expansion	4.5	4.5	4.5
14	Gel consistency	80 mm	80 mm	80 mm
15	Amylose content	21 %	21 %	21 %
16	Glycemic Index	53.5	52.5	53.1 *

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PRODUCTION OF ORGANIC SEED FOR SOIL AND HUMAN HEALTH

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Organic seed production includes growing of seed crops by a set of guidelines that prohibit the use of synthetic products/ chemicals. Growing seed crops requires a longer season since the crop must stay in the field twice as long as a conventional crop harvested for grain and also for increased monitoring to ensure high seed quality and purity. Standard production of seeds requires chemical herbicides, insecticides, fungicides, and fertilizers. The most compelling reason for using organic seed when growing organic crops is that seed produced organically causes less chemical impact on the environment. During organic seed production soil fertility and pest management is achieved through various sources like cropping patterns, organic manure, biofertilizers, cultural practices and biopesticides, including plant derived products.

Introduction

The term "organic seed" means seed produced under an organic system, ideally one that is certified. Growing crops for seed requires a longer season since the crop must stay in the field twice as long as a conventional crop harvested for grain and also for increased monitoring to ensure high seed quality and purity. Standard production of seeds requires chemical herbicides, insecticides, fungicides, and fertilizers. An increase in the amount of chemical products used on seed crops may occur due to the length of time the crops remain in the field. As a result, plant diseases and insects get more time to attack the crop during seed maturation. With these factors playing a role in conventional seed production, the challenges for organic seed production are increased. The most compelling reason for using organic seed when growing organic crops is that seed produced organically causes less chemical impact on the environment.

Suggested Organic Farming Techniques

Green manuring: Trees, shrubs, crops, grain legumes, grasses, weeds, ferns and algae provide green manure an inexpensive source of organic fertilizer to build up or maintain soil organic matter and fertility. The cumulative effects of continued use of green manures are important not only in terms of nitrogen supply, but also with regards to soil organic matter, phosphate and micro-nutrient which are mobilized, concentrated in the top soil and made available for plant growth.

Organic manure: FYM, sheep manure, crop residues, p Organic manure: oultry manure, oil cakes, composts-coir pith compost and other farm wastage. The indigenous and biodynamic preparation such as compost preparation can be used in organic nutrition management.

Vermicompost: It is the compost prepared by earthwo Vermicompost: rms. Biologically degradable and decomposable organic wastage are used as erarthworm feed.

Biofertilizer: Microorganisms to fix atmospheric ni Biofertilizer: trogen, to release and mobilize phosphorous and other nutrients. Natural fertilizers containing carrier based micro-organisms viz., Rhizobium, Azotobacter, Azospirillum, Blue Green Algae, Mycorrhizae and Phosphobacteria.

Plant products (botanicals): Plant products (botanicals): Seed hardening done with garlic extract, leaf extracts of Prosopis, Pungam,

Acacia, Calotropis etc. The decayed plant extracts can be used as liquid manure for promoting plant growth.

Mulching: It is an important technique for improving soil microclimate, enhancing soil life, structure and fertility, conserving soil moisture and energy, reducing weed growth, preventing damage by impact from solar radiation and rainfall (erosion control) and reducing the need for tillage. Widely used traditional mulches include layers of dry grass, crop residues (straw, leaves etc.), fresh organic material from trees, bushes, grasses and household refuse green manures.

Panchmukhi: Five factors of agricultural treatments adopted by the natural farmers as seed treatment, soil treatment, water treatment, environmental treatment and crop treatment are cumulatively known as panchmukhi farming process for boosting agricultural yields.

Panchagavya: It is a foliar spray prepared by organic growers using the following ingredients and methodology: Biogas slurry/cow dung 5 kg, cow urine 3 litres, cow milk 2 litres, curd 2 litres, clarified butter/ghee 1 litres, sugarcane juice 3 litres, palm sugar 1 kg, tender coconut water 3 litres, banana are the ingredients. The ingredients are mixed in a mud pot after stirring them well. Then, it is kept in a shady place for one week for fermentation. Then 3 litres of Panchagavya are diluted in 100 litres of water. This mixture is sufficient for spraying four acres. The diluted mixture has to be thoroughly stirred for 20 minutes before spraying. It can be stored for one month. It reduces vegetative growth and enhances quick flowering and also gives resistance against pests and diseases.

Organic Seed Production Practices

Land selection: Land should be organically managed. Avoid the low lying area to restrict the runoff water contamination from conventional farming system. To avoid contamination from wind, the organic farm shall be separated from conventional farm by live fence or manmade organically managed crop can be maintained as buffer zone. A buffer zone of at least 3 meters shall be maintained between conventional and organic management land. The equipment or implements used for organic management shall be cleaned before use.

Crops should be rotated to reduce pest problems and any potential for seed contamination by open pollination with similar species types. The seed production field should not have known weed problems that are too difficult to control through organic means

Land preparation: reparation: Soil should be tilled to ensure a fine seed bed, which is critical for germination, particularly with small-seeded crops. The soil should have good water-holding capacity to allow for uniform germination and continued vegetative growth. The beds should be raised and shaped depending on rainfall. Uniformity of seedbeds is especially important because the seeds are often precision planted and uniform emergence and seedling developments are required for optimum management.

Soil fertilization: It is important that the fertility of the soil is improved when producing organically since chemical fertilizers cannot be used. To ensure good soil fertility and fewer soil borne diseases, crop rotation, use of a cover crop, green manure crops, mulch, animal compost, and plant material compost can be used. There are many commercial organic fertilizers available for organic crops; the major ones are listed below:

- Composted manure used to increase nitrogen content.
- Inoculates of beneficial fungi, which work with the plant's roots to help them fix nitrogen from the air.
- Crop residues and green manures.
- Straw and other mulches
- Biofertilizer (Bacterial preparation)
- Wood ashes to increase potassium.
- Rock phosphate, often crushed rock that contains elevated levels of phosphate.
- Seaweed extract, which is not a fertilizer, but aids plant growth and resistance to pests and diseases.
- Plant preparation and botanicals extract.
- Vermiculate and Peat.

Choice of crop and varieties: Any crop of variety/hybrid except genetically modified organisms/crop which suits to the location shall be used or grown. Pest and disease resistant varieties are mostly preferred.

Seeds and planting material: Seeds/planting material shall be used from organically certified source. In case of unavailability of organic seed, untreated seeds from conventional farm shall be used for first year and for subsequent years organic seeds shall be used. In case of growing other varieties which are not grown in the first year, chemically untreated conventional material shall be used. Genetically engineered seeds, pollen, transgenic plants or plant materials shall not be allowed.

Planting techniques: Seeds are generally planted directly by drilling in the field or transplanting from a greenhouse-grown seedling. These seed transplants should be organically produced. The seeds must be planted in such a way that proper vegetative development occurs that will support fruit and seed development with proper spacing and depth in the bed.

Row spacing and plant density must allow for maximum plant development of the flower and unrestricted access to inflorescences for pollinators to ensure proper seed set. Proper spacing will also allow for improved air movement, reducing pathogens and providing space for harvest operations at the end of the season.

Rouging: Rouging: Rouging at periodical intervals to remove the off types from both in male and female lines during hybrid seed production.

Weed, pest and disease management: Management of weeds and pests is critical to ensure that organically produced seeds have high yield and quality. Weed can be managed through mulching with plant residues and other fully biodegradable materials, livestock grazing and hand weeding coupled with mechanical cultivation. The seed crop is in the field for a long period of time, there are many opportunities for multiple pathogens to interact with a single crop. To control these pathogens organically is complex and requires proper growing conditions.

1. Biological pest control: This practice is highly compatible with organic seed production. Biological control utilizes three sources of natural enemies that can be used to control harmful pests and reduce the use of organic pesticides. The first group includes parasitoid insects, which lay their eggs inside another insect. An example is the wasp Aphidius colemani which lays its eggs in aphid adults. The second group of beneficial insects is predators, which eat other insects. A common predator is the lady beetle, which preys on insects and mites. The third group includes the weed feeders. Insects such as a weevil, Hylobius transversovittatus feed on certain weeds, including purple loosestrife. To the brief biological methods include the following practices:
   - Biocontrol agent like Pseudomonas, Trichodorma.
   - Viral, Fungal Bacterial and Protozoa.
   - Introduction of predators or parasites of the pest.
   - Natural enemies like spiders, insects, mites, nematodes and birds
   - Non-synthetics control such as lures, traps and repellant.
   - Mulches and nets.
   - Sanitation to remove disease vectors, weed seeds and habitat for pest organism. Development of habit for natural enemy of the pest.
   - Botanical pesticides.
   - Crop rotation, trap crops and alternate host crop. Insect trap pheromones.

2. Physical method: In this method there is use of human effort to control insect pest and disease. The different physical method is listed below:
   - Regulation of temperature: applicable for stored place
   - Regulation of light: applicable for field crop
   - Regulation of moisture: Use for stored insect pest control
   - Use of sound waves

3. Mechanical method: The mechanical method of insect pest management includes:
   - Hand picking
   - Sieving and winnowing
   - Shaking and beating
   - Netting
   - Wrapping
   - Painting
   - Banding

Harvesting, threshing and drying: Harvesting the male parents line should be done first. Method of harvesting depends on the type of seed being produced. When harvesting dry-seeded crops, seed shattering must be prevented because seed harvest generally occurs after the crop reaches physiological maturity. To reduce shattering, the stalks of the plant need to be cut while still green and field dried, allowing for uniform seed maturation.

Cleaning and Storage: Once seeds are harvested, threshed and extracted. They should be evaluated to determine the physical purity. All seeds should be single units and all should be stored according to their individual temperature/humidity requirements. Generally moisture content should be below 12% for storage.

Seed treatment: The organic seed are treated normally with materials from organic sources. They are:

Botanicals	Biofertilizers	Cow's product	Biocontrol agent	other
Neem leaf extract	Rhizobium	Panchagavya	Pseudomonasspp.	Coconut milk
Mint leaf extract	Azatobactor	Cow milk	Trichoderma spp.	Tender coconut
Sarani leafextract	Azospirillum	Curd		Vermicompost
Prosopis leafextract	Phosphobacteria	Cow urine		Vermicompost
Arappu leaf extract		Cowdung		

As it is often not possible to produce disease-free seed and as conventional effective seed treatment with synthetic compounds is not possible, a lot of work on alternative seed treatments has been done and is still going on. The various tested treatments can be classified in several categories:

1. **Thermal treatment:** Hot water seed treatments are efficient on several crops but have to be applied with caution to avoid killing the seed. The limitation is that seed must be dried rapidly after the treatment and this is difficult at an industrial scale. To avoid that difficulty, an aerated steam method has been proposed. Because the seed is not immersed in water but exposed to hot moist air, drying is no longer a problem. The choice of temperature and its control is critical.
2. **Use of antagonists:** Several antagonists have been tested and the list is long. Some nonexhaustive results are as follows:
   - Trichoderma spp against collar rot (Aspergillus niger) on groundnut.
   - Pseudomonas chlororaphis, Bacillus subtilis, Fusarium oxyporum, Streptomyces spp against Alternaria spp on Brassica seed.
   - Bacillus subtilis against Tilletia caries on wheat.
   - Trichoderma viride against Fusarium spp and Bipolaris sorokiniana on wheat and barley. - Several antagonists against Rhizoctnia solani
3. **Natural compounds:** Essential oils, sometimes with chelator and natural detergent have been tested. Thyme and oregano oils are reported to give good results against Xanthomonas campestris pv. campestris, Clavibacter michiganensis pv. michiganensis, Botritis aclada and Alternaria dauci. A yellow mustard flour-based product, Tellecur, is reported to give good results against various pathogens, in particular Telletia caries in wheat. Chitosan is reported to give good results against Fusarium spp. and Bipolaris sorokiniana on wheat and barley. A complex product, Biokal (57% of medicinal herb extracts, 38% bio-humus extracts, 5% volatile oil and metal and trace elements) is reported to give some good results against Ascochyta pisi on pea seed.
4. **Other products:** Organic acids (lactic, acetic, citric, propionic and ascorbic) and antiseptic products such as $KMnO_4$ and $CuSO_4$ are also under tests at the moment.

Organic Seed Certification

In simplified terms, the National Organic Program Standards require for crop farms:

- 3 years (36 months prior to harvest) with no application of prohibited materials (no synthetic fertilizers, pesticides, or GMOs) prior to certification
- Distinct, defined boundaries for the operation

- Proactive steps to prevent contamination from adjoining land uses
- Implementation of an organic system plan, with proactive fertility management systems; conservation measures; and environmentally sound manure, weed, disease, and pest management practices
- Monitoring of the operation's management practices to assure compliance
- Use of natural inputs and/or approved synthetic substances on the National List, provided that proactive management practices are implemented prior to use of approved inputs
- No use of prohibited substances
- No use of genetically engineered organisms (GMOs), defined in the rule as "excluded methods"
- No use of sewage sludge or irradiation
- Use of organic seeds, when commercially available (must not use seeds treated with prohibited synthetic materials, such as fungicides)
- Use of organic seedlings for annual crops
- Restrictions on the use of raw manure and compost
- Must maintain or improve the physical, chemical, and biological condition of the soil, minimize soil erosion, and implement soil building crop rotations
- Fertility management must not contaminate crops, soil or water with plant nutrients, pathogens, heavy metals or prohibited substances
- Maintenance of buffer zones depending on risk of contamination
- Prevent commingling on split operations (the entire farm does not have to be converted to organic production, provided that sufficient measures are in place to segregate organic from non-organic crops and production inputs)
- No field burning to dispose of crop residues (may only burn to suppress disease or stimulate seed germination flame weeding is allowed)
- No residues of prohibited substances exceeding 5% of the EPA tolerance (certifier may require residue analysis if there is reason to believe that a crop has come in contact with prohibited substances or was produced using GMOs)

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POTENTIAL OF PHENOMICS FOR TRAIT DISSECTION AND GENE MAPPING

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The food production system in India has to feed about 1.6 billion of Indians by 2050. The magnitude of challenge in accomplishing this task attains enormous dimensions mainly in 3 aspects viz. limited and shrinking resources for agriculture, concerns about technological foot prints on human and environmental health and predicted amplification of factors contributing to unfavourable environments due to climate change. Limited resources mainly land and water continue to constrain the food production system as their sectors contributing to the national economy will draw their share during development while episodes of droughts can place tremendous pressure on water supply. Use of excess fertilizers and water have left their foot print on water and land quality which tend to become unsuitable for use unless treated by using modern technologies. Impact of climate change is being witnessed in different forms such as increase in frequency and intensity of drought, flood etc. The traditional phenotyping procedures- which deal with plant characteristics have not allow eda thorough functional analysis and have not led to a functional map between genotype and phenotype. This is often due to sufficient data on phenotype of plant to predict such relations with greater power. A focus on overcoming these shortcomings has led to an emerging and increasingly important branchofbiologicalsciencestermed—phenomics(Furbank,2009;FurbankandTester, 2011). Phenomics is a technology that enables high-through put phenotyping for crop improvement in response to present and future demo graphic and climate scenarios. Phenomics has been evolved as a novel area of biology and involves high-dimensional phenotypic data at multiple levels of organization for full characterization of the complete set of phenotypes of a genome. A plant phenotype consists of structural, physiological, and performance-related traits of a genotype in a given environment.

Phenomics is being extensively used for establishing phenotype genotype relationship and QTL mapping. Some examples of biparental population-based QTL mapping and genome-wide association (GWA) mapping using data from NGP phenomics are given in the Table 1. The relationship between QTL mapping under field conditions and controlled environment phenomics facility where plants were grown in pots were studied. Phenomics approach was used to map QTLs in barley for growth under drought stress including growth rate and water use efficiency at seedling stage. Several QTLs showed co-localization with previously mapped QTLs under field conditions. A novel QTL that significantly increased biomass by about 36% was identified (Honsdorf et al. 2014). Further, in wheat by using phenomics approach, about 20 QTLs with strong effects, accounting for between 26 and 43% of the variation were in a controlled environment showing that the G×E interaction could be reduced. Comparative analysis of QTLs mapped using phenomics approach with that are previously mapped under field conditions showed co-localization (Parent et al. 2015). Combination of phenomics and genome-wide association studies (GWAS) in rice, 141 associated loci for 15 traits, 25 of which are previously known genes (Yang et al. 2014). These performance evaluation studies demonstrated that phenomics approach is a suitable alternative to replace traditional laborious field-phenotyping for QTL mapping and positional cloning.

Table 1. Examples of phenomics aided QTL mapping (Yang et al. 2014)

Crop/ Model plant	Population	Phenomics platform	QTLs mapped	Remarks	Reference
Arabidopsis	162 RILs and 92 NILs derived from a Cvi) × Ler cross	Visual image every 2 min for 8 hr; Controlled environment	QTLs for mean tip angle at each of the 241 time points	Time-dependent QTL were detected on chromosomes 1, 3, and 4	Moore et al. 2013
Triticale	647 doubled haploid lines derived from four families; GWA mapping	A tractor pulled trailer equipped with two light curtains, three laser distance sensors, two 3D-Time-of-Flight cameras; Field conditions	23, 25 and 17 QTLs at 3 development al stages; Two major QTLs	One major QTL on chromosome 5R is active throughout plant development while the other major QTL on chromosome 5A contributes strongly to biomass at the early stage	Busemeyer et al. 2013
Rice	171 RIL and parental plants Bala × Azucena	Visual imaging of root systems growing in nutrient-enriched gellan gum at days 12, 14, and 16 Post planting	89 univariate QTLs across all days of imaging for various RSA traits	Many univariate and multivariate QTLs that we identified colocalized with previously identified root trait and drought resistance hotspots	Topp et al. 2013
Barley	47 wild barley ILs of the S42IL library and the recipient parent Scarlett	RGB images; gravimetric measurement of water use, end point phenotypic data; Controlled environment	44 QTL for 11 traits;	Three QTL were identified for Absolute Growth Rate Integral (AGRI); Two QTL were detected for WUE	Honsdorf et al. 2014
Triticale	647 DH lines derived from four families	phenomics data of biomass yield generated at three developmental stages; Controlled environment	10, 10, 9 QTLs were mapped for biomass at 3 stages respectively,	Of the several QTLs mapped, only 4 were common in all three stages, while 5, 4, and 4 were specific for biomass at satge1, 2 & 3 respectively	Liu et al. 2014

Arabidopsis	324 accessions; GWA mapping	Visual top-view imaging and end-point fresh weight determination; Controlled environment	22 QTLs for fresh weight (endpoint), projected leaf area (at 12 different growth stages) and modelled parameters	Many of the growth QTLs would not have been identified with only endpoint fresh weight data	Bac-Molenaar et al. 2015
Rice	378 diverse rice genotypes; Salinity tolerance; GWA mapping	Visible & Fluorescence imaging; Controlled environment	55 QTLs	Only 26 QTLs could be detected at one time point	Campbell et al. 2015
Rice	553 genotypes phenotyped for salinity tolerance; GWA mapping	Visible image (one top and two side views); Controlled environment	Several QTLs for RGR, TR and TUE at different intervals	The QTL on chromosomes 11 is strongest in the first interval after salt stress (2–6 days after treatment), but not in the last interval (9–13 days after treatment)	Al-Tamimi et al. 2016
Arabidopsis	324 accessions; GWA mapping	Visual top-view imaging, end-point fresh weight determination, gravimetric measurement of water use; Controlled environment	Twenty-one SNPs associate with FW, PLA over time, RWC and model parameters	Six time-dependent drought-QTLs; Of these, for five QTLs, most likely candidate genes could be identified	Bac-Molenaar et al. 2016
Sorghum	97 RILs and the two parental lines BTx623, IS3620C)	RGB time-of-flight depth camera; Controlled environment	Five QTLs were mapped; alleles closely linked with the sorghum Dwarf3 gene, an auxin transporter, was found to play	Many of the QTLs identified via image-based phenotyping overlapped with QTLs for comparable traits discovered in prior field experiments	McCormick et al. 2016

Superiority of non-destructive phenomics over conventional field phenotyping

Conventional phenotyping is often destructive and phenotypic data is obtained at few crop growths stages or at the end of the crop cycle. Automated NGP using phenomics technologies captures multiple phenotypic data throughout the crop growth stages and thus adds time-scale to the phenotypic data which is not available in the conventional phenotyping. Time-scale phenotypic data during different growth and development of crop is necessary for mapping the QTLs for component traits that contributes to crop development during specific growth stages. Plant growth models quantify 1) absolute growth rate (AGR), 2) relative growth rate (RGR), and Net Assimilation Rate (NAR), which require measuring biomass/leaf area at successive time points. However, raking these destructive measurements in field is limited due to space, time and cost limitations, and thus often only two-point measurements are taken and fitted into simple logistic models. However, the results do not often fit with observations (Paine et al. 2012). Phenomics is highly useful in measurement of plant growth and development on the organism-wide scale, and thus it is highly useful to measure dynamics of various component physiological traits that contribute to yield and stress adaptation. Automated phenomics enables the plant scientist to quantify traits that are difficult to measure under field conditions such as relative growth rate, transpiration, and water-use efficiency (WUE). Direct quantification of WUE requires gravimetric measurements of amount of water used for evapotranspiration and plant biomass. It is difficult to directly measure WUE for large number of germplasm lines and mapping populations. Hence only limited success has been achieved in identification of donors and QTLs for this important trait. Further, the physiological causes of the genotypic differences are not understood. Temporal measurements of water use and biomass in automated phenomics facility using S. viridis and domesticated S. italica revealed that both have similar biomass production, but S viridis maintained the water-use efficiency, while S. italica become less efficient growth under water-deficit. Conventional end point measurement could not have detected this temporal physiological response of genotypes in WUE as the soil available water changes (Fahlgren et al. 2015a). The dissection approach uses model-assisted methods to dissect complex phenotypes such as yield and drought tolerance into more simple and heritable traits. In barley, phenomics approach was used to identify novel traits, such as maximum growth rate and stress elasticity, associated with plant growth and drought tolerance. These traits are not measurable via traditional phenotyping approaches. In addition, several image-based traits and model-derived parameters were identified which have potential for subsequent dissection of the genetic basis of complex agronomic traits (Chen et al. 2014).

The genetic dynamics of plant traits were revealed by the introduction of time-axis by the use of automated phenomics to dissect the genetics of complex traits over the time-scale. Generally, heritability for a specific trait in a crop is considered stable, and traits with moderate to high heritability are given preference for genetic improvement. Automated image acquisition after every 2 min for 8 h of imposition of gravitropism and QTL mapping in Arabidopsis led to the mapping of time-dependent QTLs (Moore et al. 2013). Leaf growth and development, a major determinant of photosynthetic capacity, is highly regulated by moisture and nitrogen availability. Genetic dissection of this trait was difficult as it needs measurement of this trait throughout a growing season. Using a time-lapse image analysis approach of phenomics, this complex trait was dissected and found to be highly heritable in Arabidopsis (Zhang et al. 2012). The complexity and plasticity of traits such as biomass and yield in triticale was studied with image-based phenotyping at three developmental stages. QTLs mapping identified some stage-specific QTLs and some QTLs common for two or more developmental stages, demonstrating a temporal contribution of these QTLs to the trait (Liu et al. 2014). Phenomics of rosette growth in 324 accessions of Arabidopsis was compared with end-point weight measurement for GWAS. Use of temporal growth data detected time-specific QTLs which were undetected by endpoint measurement. Eleven of these time-specific candidate genes identified

were annotated to be involved in the determination of cell number and size, seed germination, embryo development, developmental phase transition, or senescence. Of these eight genes have been previously demonstrate role with mutants and overexpression studies, suggesting the time-specific QTLs are true regulators of growth and development (Bac-Molenaar et al. 2015). A recent study with non-destructive high throughput phenome of Arabidopsis accessions over spatial and temporal scale revealed that heritability for some traits is dynamic. The heritability of ΦPSII (Fq′/Fm′, a useful proxy for the light use efficiency for CO2 fixation) showed recurrent daily rise which was unaffected by the difference in light intensity, while that of chlorophyll reflectance index and projected leaf area (PLA, an indirect estimate of estimate of above ground biomass) gradually changed through time and responded strongly to light intensity. The heritability of PLA showed significant temporal flexibility ranging from 0.04 to 0.83 within the course of 6 h. This suggests the necessity of organism-wide spatial and temporal phenotyping in phenomics to understand the heritability of traits of agricultural importance (Flood et al. 2016). Thus, spatial and temporal phenotyping of crops in phenomics facility will help understand and improve these important traits under water and nitrogen limited conditions.

In silico Phenotyping

Phenomics is highly useful for GWAS and linkage mapping of complex traits such as biomass and height in triticale (Busemeyer et al. 2013; Würschum et al. 2014), root architecture in rice (Topp et al. 2013), yield component in rice (Yang et al. 2014), root gravitropism in Arabidopsis (Moore et al. 2013), etc. Phenomics was employed to map salinity tolerance using 378 diverse rice genotypes. Visual image-based growth analysis led to the identification of a genomic region on chromosome 3 for the early growth response, while chlorophyll fluorescence imaging identified a region on chromosome 1 that regulate both regulates both the early growth rate and long-term ionic stress effects under salinity stress (Campbell et al. 2015). Rice genome is predicted to encode 37,544 genes. Functions of the some of the genes have been elucidated at molecular level, and their impacts on some phenotypes have been studied. However, effect of individual genes on whole plant phenome is critical ultimately to predict the plant traits from plant genome in different environmental conditions. An attempt has been made in yeast to study the phenotypes of essential gene mutations in yeast and PhenoM (Phenomics of yeast Mutants) database was developed (Jin et al. 2012). Loss function mutants, transcriptome and phenomics data was used to elucidate the differential functions two stress responsive genes AtRD22 and AtUSPL1belonging to BURP domain gene family in Arabidopsis (Harshavardhan et al. 2014). However, such efforts are limited in important food crops such as rice and wheat.

Development of a gene-based crop model to prediction of complex traits under diverse environmental conditions is an important area of research. For instance, an ecophysiological model predicts pre-flowering duration as affected by temperature and photoperiod was developed using barley RILs. Along with this, QTLs were mapped for the model input trait and values of the model-input traits predicted for the RILs from the QTL were fed back into the ecophysiological model. This model could predict the flowering time for eight field trial environments, and thus ecophysiological model was capable of extrapolating QTL information from one environment to another (Yin et al. 2005). Similarly, wheat heading date could be predicted by using ecophysiological crop simulation model with QTL based parameter inputs (Bogard et al. 2014). Using the marker-based parameter trait values, marker-based values of ILs for seven yield component traits were estimated and were fed to the GECROS model. This model could simulate yields of the ILs under well-watered and drought conditions, and identify virtual ideotypes which had 10–36% more yield than those based on markers for yield per se (Gu et al. 2014). Combining crop simulation models with genomic information and genetic modelling can accelerate delivery of future cereal cultivars suitable for different target environments. However, the robustness of model-aided ideotype design need to be further be enhanced through the inputs from phenomics and genomics and multi-model ensembles (Rötter et al. 2015). In India such efforts are totally missing now. We need to introduce gene/QTL and genomics information into existing ecophysiological models, and improve crop models based on information for lower organizational levels for complex traits (Kumar et al. 2016).

Image Processing, IAPs and Phenome Data Bank

Recently, significant progress has been made in development of image processing algorithms for quantificationof phenotypic parameters (Li at al. 2014, Fahlgren et al. 2015b, Singh et al. 2016). Thermal imaging which measures plant temperature, a surrogate for stomatal conductance, can be combined with visual images to differentiate shaded area from leaf area that is fully sunlit and a thermal index based on temperature differences between the canopy and reference surfaces was developed to calculate stomatal conductance and stress monitoring in Vitis vinifera (Leinonen and Jones 2004, Möller et al. 2007). A method for the segmentation and the automated analysis of time-lapse plant images from phenotyping experiments was developed using a plant appearance model implemented with Gaussian mixture models, which utilizes incrementally information from previously segmented instances (Minerviniet al. 2014).A fully automatic approach to image based 3D plant reconstruction was developed (Pound et al. 2016).Hyperspectral imaging containing reflectance values of continuous wavebands of the electromagnetic spectrum from Visual (400–700 nm), near-infrared (NIR, 700–1000 nm) and short wave-infrared (SWIR, 1000–2500 nm) are influenced by physiology and biochemical composition of plants. To uncover latent hyperspectral characteristics of diseased plants reliably, the hyperspectral images are converted into a corpus of text documents, and probabilistic topic models were applied to identify content and topics of documents. By this approach, intuitive tool for hyperspectral imaging has been developed to automatically track the development of three foliar diseases of barley (Wahabzada et al. 2016).Multimodal fusion methodology consisting of visual colour images and NIR reflectance images were used to study the dynamic phenotypic responses of a C4 cereal crop plant to nitrogen and water deficiency over time (Neilson et al. 2015). Machine learning (ML) tools for extracting patterns and features from the image data and multimodal fusion of trait information from different kinds of images need to be developed to enable stress phenotyping (Singh et al. 2016).Phenome database with curated and labelled phenome data will be useful to expedite both discovery and application in crop breeding (Krajewski et al. 2015).

Although image analysis software is provided by LemnaTec in the phenomics facility, significant research work is needed to develop models to estimate relevant phenotypic traits values from sensor measured digital images. Image acquisition in phenomics is relatively simple but data analysis to retrieve required parameters is not. Several methods are being developed for data analysis. Leaf area measurement is often complicated by overlap of leaves. For precisely measure the leaf are, a novel computational model called HPGA (High throughput Plant Growth Analysis) was developed to measure leaf area individually by using parameters such as leaf tips and the short curvature areas around them, and length to estimate the area in Arabidopsis (Paine et al. 2012). Since the leaf length-to-area model is genome specific, we need to develop such models for quantification of leaf area in rice and wheat. Some progress has been made in automated multimodal phenotyping using phenomics facility. The Plant Accelerator (®) at The University of Adelaide, Australia, analysed the phenome of sorghum under water-limited conditions with different levels of fertilizer. Using color RGB and NIR images, the study could identify accurately genotypic differences using R scripts based robust parsimonious models (Neilson et al. 2015). Combination of machine learning (ML) algorithms and computer vision appears to be a promising approach. Testing of three different algorithms: k-nearest neighbour (kNN), Naive Bayes Classifier (NBC), and Support Vector Machine revealed that different

ML algorithms for segmentation are required for different kind of images (Navarro et al. 2016). A fully automated approach to image based3Dplantreconstruction was developed based modelling of complex architecture of leaf surfaces in wheat and rice (Pound et al. 2016). Hyperspectral remote sensing is an automatic, quick and non-destructive method of assessing plant growth parameters, water and nutrient levels in crop plants. Team at IARI has employed different univariate and multivariate models to assess foliar N and relative water contents from captured crop spectra (Sahoo et al. 2015). They also explored physical radiative transfer models for retrieval of plant biophysical parameters like LAI, chlorophyll content and water from hyperspectral Bidirectional Reflectance factor (BRF) data on crops like maize, soybean, wheat and mustard both at controlled field condition and regional scale (Mridha et al. 2015, Tripathi et al. 2012). BRF data were further explored to characterize plant geometry which can further be used for genotypic discrimination and retrieval of morphometric parameters. Visible RGB image was analysed and indexed for assessing leaf area and chlorophyll content (Das et al, 2016). The hyperspectral reflectance data is used for genotypic discrimination, assessment of sugar levels in plants and water-deficit stress levels in rice and wheat crops identifying differential response of genotypes to water deficit stress (Das et al. 2016, 2017, 2018). Team also initiated drone-based field phenotyping of rice and wheat genotypes. Recent trends in plant phenomics have been to explore standalone use of hyperspectral imaging sensors for retrieval different biochemical and biophysical parameters. Fusion and processing of multimodal data acquired through sensor or sensors is many times preferred for assessing parameters with better accuracy which otherwise not possible.

The phenome data from plant phenomics is growing exponentially. One of the major issues the determination of the quality of phenotypic data, i.e. to remove system errors in the data collection process from the biological responses. The Integrated Analysis Platform (IAP) is highly useful for complete end-to-end pipeline for large-scale image based phenotyping, starting from the image capture to image analysis, extraction of relevant phenotypic component traits based on relational models, data management, to the automated generation of experiment reports (Klukas et al. 2014).A dynamic filter was developed to effectively identify the abnormalities in time-series quantum yield of photosystem II phenotype data (Xu et al. 2015). The Plant Genomics and Phenomics Research Data Repository (PGP) was initiated by the Leibniz Institute of Plant Genetics and Crop Plant Research and the German Plant Phenotyping Network. PGP is an infrastructure to comprehensively publish voluminous data on phenomics and genomics, and fulfils the FAIR data principles-findable, accessible, interoperable and reusable. PGP is registered as research data repository at BioSharing.org, re3data.org and OpenAIRE as valid EU Horizon 2020 open data archive (Arend et al. 2016). With a vision of transforming science through data-driven discovery, National Science Foundation, USA funded the establishment of CyVerse in 2015. It provides powerful computational infrastructure to handle huge datasets and complex analyses, thus enabling data-driven discovery in life sciences. CyVerse offers powerful extensible platforms, data storage, bioinformatics tools, image analyses, cloud services, APIs, etc. (http://www.cyverse.org/). With large number of Institutes in India are involved in genomics and availability of automated phenomics platform in four of the ICAR Institutes viz, IARI, CRIDA, IIHR and NIASM warrant development of data repository similar to that of PGP in India.

Phenomics for Crop Management

Besides the tremendous potential of phenomics in basic sciences and crop breeding, it has huge potential in crop management and precision agriculture. The sensors used for non-invasive image acquisition can be loaded in drones and Unmanned Aerial Vehicles (UAVs). Drones and UAVs with different kinds of sensors (RGB Visual, IR Thermal, Multispectral and Hyperspectral) can be used to fly over a large area of crop field to obtain phenotypic information such as phenological stage, crop health, water status, and nitrogen status, etc. (Vergara-Díaz et al. 2016; Gracia-Romero et al.

2017) This information can be useful for variable rate application or precision application of water, nutrients and agrochemicals in the necessary areas of the crop field (Figure 1).

Figure 1. Use of drones for phenotyping. Inset shows image obtained from the Drone clearly distinguishing crop with different irrigation and nitrogen treatments.

Conclusion and Perspectives

Recent advancements in use of NGP with phenomics platform enhanced the phenotyping capabilities as compared to few traits measured by conventional methods. Performance evaluation studies have shown that controlled environment as well as field phenomics is a suitable complementary approach, and in certain cases such as biotic stress, resource use efficiency and positional cloning phenomics can replace traditional laborious field-phenotyping. Besides GWA mapping, phenomics will be very useful in Phenome-wide Association Studies (PheWAS). Significant progress has been made in PheWAS to identify SNP-disease association in medical sciences. The availability of deep phenotypic data in spatial and temporal scale from NGP in phenomics is expected to accelerate PheWAS in plants. Besides, deep phenotypic data from phenomics will be very useful in training genomic selection models more accurately, and thus aid in genomic selection in crops. Further phenome features can also be used for phenomic selection (PS) in analogy with GS as complementary method (Kumar et al. 2016). We need to develop human resource in the area of image analysis and big data science to effectively use the phenomics for accelerated analytical breeding for crop improvement.

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INDIVIDUAL AND COMBINED EFFECTS OF DROUGHT AND SALINITY ON PHOTOSYNTHETIC PARAMETERS OF BRASSICA JUNCEA SP. SUPPLEMENTED WITH SALICYLIC ACID

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Introduction

Brassica juncea (L.) (Indian mustard) Czen and Cross are economically important agricultural commodities which are grown in more than 50 countries of the world (Bhardwaj et al. 2015). There are so many distribution areas which are centered in the north-west agro-climatic region, where either maximum ground water sources are highly saline or water available is not required to sustain growth of plants. Bohra and Sanadhya (2015) and Fathiet al. (2016) have well reported in their review that abiotic stresses, such as drought, salinity, high and low temperatures are serious obstacles for field crops especially in the arid and semi- arid regions of the world. Water deficit is the main cause of desertification or salinization of cultivated land due to drought and salinity stresses. However, plant responses to drought and salinity have much in common. Therefore, water scarcity causes an increase of solute concentration in environment, leading to an osmotic flow of water out of plant cells. This in turn causes high solute concentration inside plant cells, then low water potential and membrane disruption along with essential processes like photosynthesis. In the past few decades, among many strategies such as plant breeding, genetic engineering, plant growth regulators (PGRs) etc. used to combat drought and salinity stresses, exogenous application of plant growth regulators has received considerable attention. Salicylic acid is considered to be an endogenous plant growth regulator of phenolic nature which enhanced the leaf area and dry mass production in B. juncea. Jaiswal et al. (2014) and Shakirova et al. (2016) well stated that SA or ortho-hydroxy benzoic acid and other salicylates are known to affect various physiological and biochemical activities of plants and may play a key role in regulating their growth and also productivity.

Results

Chlorophyll is majorcomponent of chloroplast for the process ofphotosynthesis and relative content of chlorophyll has apositive relationship with photosynthetic rate. Chlorophyll content decreased markedly upon imposition of stress. The decrease in photosynthetic pigments under water deficit conditions has been considered typical symptoms of oxidative stress and may be the result of pigment photo-oxidation and chlorophyll degradation. The decrease in carotenoids, under stress conditions, caused degradation of β-carotene and formation of zeaxanthins, which are apparently involved in protection against photo-inhibition. With SA treatment, both varieties showed more chlorophyll content in comparison to untreated seedlings.

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Table No. 1. Effect of SA application on drought and salinity-induced changes in photosynthetic pigments (Chlorophyll a, b, a+b and carotenoids) (mg g^{-1} FW) of two B. juncea cultivars at 7th day after sowing (values are mean ± SE of three replicates)

Drought stress	Chl a (µg/ml)	Chl b (µg/ml)	Chla+b (µg/ml)	Carotenoids (µg/ml)	Salt stress	Chl a (µg/ml)	Chl b (µg/ml)	Chla+b (µg/ml)	Carotenoids (µg/ml)
Pusa-AG.									
Control	0.84±0.01	0.84±0.01	0.84±0.009	0.84±0.025	**Control**	0.84±0.017	0.82±0.01	0.83±0.01	0.82±0.005
5%	0.66±0.02	0.15±0.005	0.40±0.27	0.415±0.012	**50mM**	0.72±0.01	0.16±0.005	0.44±0.30	0.40±0.002
10%	0.54±0.01	0.14±0.01	0.34±0.21	0.21±0.011	**100mM**	0.61±0.005	0.15±0.005	0.38±0.25	0.20±0.003
15%	0.45±0.01	0.12±0.005	0.29±0.17	0.11±0.001	**150mM**	0.51±0.011	0.13±0.005	0.32±0.21	0.11±0.002
Cnt+SA	0.86±0.01	0.95±0.005	0.90±0.05	0.97±0.01	**Cnt+SA**	0.92±0.056	0.96±0.005	0.94±0.04	0.92±0.015
5%+SA	0.77±0.01	0.17±0.005	0.47±0.32	0.63±0.015	**50mM+SA**	0.87±0.011	0.22±0.01	0.54±0.35	0.62±0.003
10%SA	0.64±0.01	0.16±0.005	0.40±0.26	0.46±0.003	**100mM+SA**	0.76±0.015	0.18±0.005	0.47±0.31	0.45±0.003
15%SA	0.55±0.01	0.13±0.01	0.34±0.23	0.28±0.001	**150mM+SA**	0.66±0.015	0.16±0.005	0.41±0.27	0.27±0.0005
CS-52					**CS-52**				
Control	0.81±0.02	0.78±0.01	0.59±0.02	0.78±0.002	**Control**	0.81±0.015	0.76±0.015	0.78±0.03	0.81±0.003
5%	0.63±0.03	0.21±0.020	0.42±0.23	0.48±0.064	**50mM**	0.66±0.026	0.20±0.005	0.43±0.24	0.42±0.001
10%	0.49±0.01	0.18±0.005	0.33±0.17	0.24±0.001	**100mM**	0.58±0.005	0.18±0.005	0.38±0.21	0.21±0.001
15%	0.40±0.01	0.16±0.005	0.28±0.13	0.17±0.001	**150mM**	0.46±0.015	0.16±0.005	0.31±0.16	0.15±0.001
Cnt+SA	0.86±0.01	0.86±0.02	0.86±0.01	0.88±0.004	**Cnt+SA**	0.88±0.011	0.86±0.02	0.87±0.02	0.92±0.002
5%+SA	0.75±0.02	0.22±0.005	0.49±0.29	0.67±0.002	**50mM+SA**	0.72±0.01	0.22±0.005	0.47±0.27	0.61±0.001
10%SA	0.58±0.01	0.21±0.005	0.39±0.20	0.48±0.003	**100mM+SA**	0.65±0.005	0.21±0.005	0.43±0.24	0.45±0.003
15%SA	0.52±0.01	0.16±0.005	0.34±0.19	0.29±0.003	**150mM+SA**	0.53±0.01	0.19±0.005	0.36±0.18	0.26±0.001

Table No. 2. Effect of SA treatment on combined stress induced changes in photosynthetic pigments (Chlorophyll a, b, a+b and carotenoids) (mg g^{-1} FW) of two B. juncea cultivars at 7th day after sowing (values are mean ± SE of three replicates)

Treatment	Chl a (µg/ml)	Chl b (µg/ml)	Chla+b (µg/ml)	Carotenoids (µg/ml)
Pusa-AG				
Control	0.85±0.01	0.82±0.01	0.83±0.01	0.81±0.001
Com.1	0.68±0.01	0.18±0.005	0.43±0.27	0.42±0.001
Com.2	0.61±0.005	0.17±0.01	0.39±0.24	0.21±0.001
Com.3	0.52±0.01	0.13±0.005	0.32±0.21	0.13±0.002
Cnt+SA	0.86±0.005	0.9±0.02	0.88±0.20	0.94±0.002
Com.1+SA	0.75±0.01	0.22±0.01	0.48±0.29	0.61±0.003
Com.2+SA	0.68±0.01	0.19±0.005	0.43±0.26	0.46±0.0005
Com.3+SA	0.62±0.01	0.15±0.005	0.38±0.25	0.20±0.002
CS-52				
Control	0.82±0.01	0.77±0.01	0.79±0.02	0.82±0.001
Com.1	0.67±0.01	0.16±0.005	0.41±0.27	0.41±0.001
Com.2	0.57±0.005	0.14±0.005	0.35±0.23	0.20±0.002
Com.3	0.47±0.02	0.11±0.005	0.29±0.19	0.16±0.001
Cnt+SA	0.87±0.01	0.87±0.01	0.87±0.01	0.93±0.002
Com.1+SA	0.74±0.01	0.21±0.005	0.47±0.28	0.62±0.002
Com.2+SA	0.67±0.005	0.19±0.005	0.43±0.26	0.47±0.0005
Com.3+SA	0.58±0.01	0.17±0.005	0.37±0.22	0.28±0.001

Discussion

In accordance with the results, Ahmed et al. (2016) reported that carotenoids is less sensitive than chlorophyll and the ratio of total chlorophyll to carotenoids reduces with enhanced severity levels of drought in *Triticumaestivum.* The observation of the present research work showed conformity with the previous study done by Jaiswal et al. (2014) who reported decrease in photosynthetic pigments of *Glycine* max under drought and salinity and improvement with SA treatment. These results were consistent with observations recorded by Sayyari*et al*. (2013) in Lettuce plants subjected to water deficit conditions. Chlorophyll is major component of chloroplast for the process of photosynthesis and relative content of chlorophyll has a positive relationship with photosynthetic rate. We observed that SA treatments enhanced the chlorophyll and carotenoids contents even under stressed conditions, but the efficiency of exogenoussalicylic acid depends on various factors such as species, stage of development, application method andconcentration (Chauhan *et a*l, 2019 and Kumar et al, 2020). Therefore, the effectiveness of SA on chlorophyll contentmay be due to one of the above mentioned reasons and the way of treatment may be standardized for field performance.

Conclusion

Role of Salicylic acid was evaluated with respectto photosynthetic pigments concentration in drought,salinity and their combined stress affected in vitro raisedseedlings of two B.junceavarieties. Both the varietiesshowed improved photosynthetic pigment concentration.

An Integrated View and Future Prospects

- As one of main focuses in plant-abiotic stress research, studies on B. juncea seedlings under combined stress of drought and salinity and to mitigate the toxic effects of stress by SA treatment are still rare.
- In future studies, it will be helpful for developing stress tolerance varieties of B. juncea species under osmotic stress conditions for high yield which is still in high demand for researches.
- The in vivo experiments can be performed in future to prove the potentials of PGR used.

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WORKING OUT A TECHNOLOGY OF USE OF NAP (NATURAL ACTIVATOR OF PEDOGENESIS) AT CULTIVATION OF BASIC CROPS IN TERMS OF ALTA

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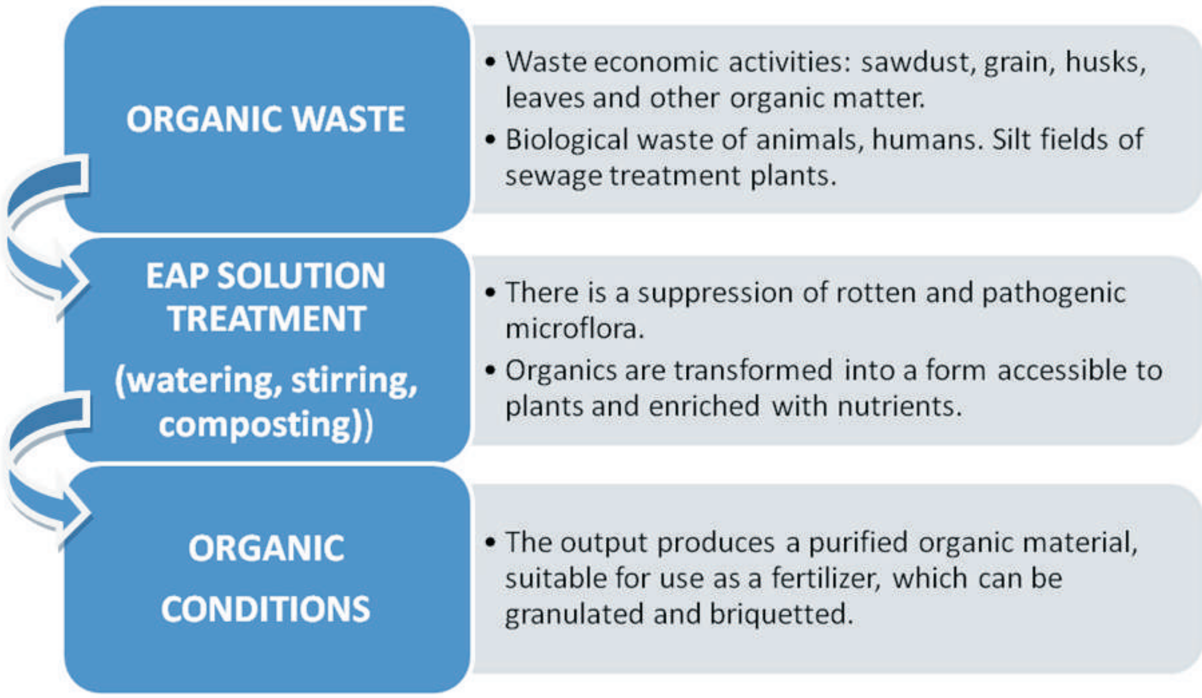
Our company has been producing peat-humic fertilizers and bio-preparations based on paste-like concentrate "EAP" in various modifications developed for specific conditions and tasks, as well as taking into account the peculiarities of different climatic conditions and ecosystems for more than twenty years. Experience of practical and scientific works speaks about efficiency of our products for application in the following directions:

1. **Fertilizers for increasing yield, restoring fertile soil layer, combating desertification and reclamation of landfills.**
2. **Bio-preparations for treatment and neutralization of life wastes, silt fields and waste water.**
3. **Bio-preparations for environment restoration after anthropogenic and anthropogenic impact.**
4. **Detergents and fodder additives for animal husbandry.**

It is well known that preparations and fertilizers containing large amounts of organic and humic substances have a positive impact on the recovery of the fertile layer in soils. On the basis of EAP, we have developed technology to restore this layer in impoverished and poor soils.

This technology consists in the application of granular, compressed organic matter before planting. The fertilizer can be applied to the soil together with the seeds after ploughing and subsequent harrowing. The size of the granules is adapted to the specific seed drill



An example of such work is a mixture of coniferous and EAP sawdust. Laboratory analysis of this mixture in the German (LUFA-ITL) laboratory showed that its quality meets the requirements for organic fertilizers of the European Union. This mixture is produced under the brand name "EAP" bio-stimulus. Its application was tested and tested on sandy eroded soils of the Altai Priboga region by the order of the General Forestry Administration of Barnaul city.

We have also obtained a positive result in the acclimatization of sea buckthorn seedlings and honeysuckle seedlings at the leading enterprise of the Altai region on the production of sea buckthorn oil JSC "Sibirskoye" when treating the seedlings before planting them in the field. Honeysuckle seedlings were planted in the soil, introducing into the planting hole organic mixture "EAP" Bio-stimulus. By the end of summer the acclimation rate of honeysuckle seedlings in the pilot area was 80-85%, and in the rest of the field it was no more than 10%. In spring the percentage of overwintered bushes at the experimental plots was also several times higher and reached 90-95%. According to the results of application, it can be concluded that introduction of "EAP" stimulates root formation and vegetative development of seedlings making plants more resistant to transplantation and overwintering.

The preparation is prepared for production in the form of pellets and tablets, in which it is convenient to plant shrub cuttings. Such pellets and pellets store moisture well, preventing its evaporation, and accumulate it in itself (up to 100% of volume) due to night-time temperature fluctuations and dew drop.

Also, we conducted an experiment to model the natural and soil conditions of Mongolia, on planting in a 100 gram tablet of the preparation "EAP" Bio-stimulus placed in the gravel screening. Gravel screening with particle size from 4 to 7 mm was selected, was washed under running water to remove silt, clay and other mineral soluble substances. Then a tablet was placed in an experimental container, in the center of which a freshly cut stalk of willow was planted, and the seeds of marigold and radish were planted there.

Thus, 3 containers with different composition of our preparation were prepared, including a sample made of sludge from the treatment plant of Ulan Bator, treated by "EAP".

The pills have been dropped out.

Plantingcuttingsin a pill

Practical works in Mongolia were conducted in 2013 in Hovd city, together with the Department of Forestry and Environment. There "EAP" was applied by watering and soaking when planting lawns, shrubs, tree plantations and potatoes on steppe and desert soils. The experience in preparation of organic mixtures based on EAP concentrate and animal waste (barto) was also applied.

Application of bio-preparation "EAP" for neutralization and processing of biological wastes of human life activity

In the capital city of Mongolia, Ulaanbaatar, work was carried out on a sewage treatment plant. Silt maps were processed by spraying with a working solution from mobile plants. According to the results of industrial tests on filtration fields of Ulan Bator waste water treatment plant, 90% of the waste water treatment plant waste water treatment plant waste water treatment plant waste water treatment plant waste water treatment. The content of odor-bearing compounds of ammonia decreased in 10 times, hydrogen sulfide in 3 times, and the number of microbes and bacteria in thousands of times.

As a result, compost was obtained from the recycled material, which was soil in terms of quality and composition. Laboratory analysis of

mixtures in the Federal State Agrochemical Service showed the absence of pathogenic micro flora and sufficient content of micro and macro elements necessary for plants.

In the future, treated sludge can be used as organic fertilizer in agriculture or for application to humus-poor soils when planting desert lands. The resulting product is suitable for pressing for tablet-shaped fertilization.

Restoration of natural environment after man-made and anthropogenic impact

Neutralization of exposure to agricultural pesticides (pesticides, herbicides, etc.).

Bio-preparation can be used together at the application of toxic chemicals, which ensures their decomposition after the active impact of toxic chemicals on the treatment facility. The preparation is also used for decomposition of excess pesticides in soils. Tests of the Siberian Branch of the Russian Academy of Sciences together with the Institute of Water - Environmental Problems in Artybash, Republic of Altai (in the zone caused by the high concentration of toxic chemicals in the soil, COP-DDT, HCCG, u-GCCG) have shown that for 2 months 3-fold application of EAP reduces the content of DDT and metabolites by tens of times.

Neutralization of radionuclide's and salts of heavy metals.

The tests were conducted "2002-2004-2006. FGU SAS "Biyskaya" of the Altai Territory. Institute of Geology, Geophysics and Mineralogy SB RAS, Novosibirsk, Russia. It was found that the application of the EAP bio-preparation ensures the binding of radionuclide's and salts of heavy metals and their transformation into water-soluble complexes. This leads them out of the natural biological turnover. Thus, when treating contaminated soil with bio-preparation, the content of cadmium salts in it decreased by 2-3 times and gross lead by 3-4 times.

Detergents and fodder Additives

Also at the request of the Mongolian side, we have developed several products based on EAP bio-preparation for prevention, treatment of sheep skin diseases.

- The preparation for effective treatment of Wolfarthiosis, a skin disease caused by the tungsten fly.
- Preparations for sheep bathing as well as for dripping on the animal's knoll.
- The preparation, which contains both healing wounds and substances that prevent skin diseases.

Application of bio-preparation "EAP" as an organic feed additive stimulates and activates physiological and biological processes in living organisms. The bio-preparation is harmless in recommended doses for animals and humans. It has no allergic, embryo toxic or carcinogenic properties.

In animal husbandry, the use of hamates leads to faster growth of animals, reduced incidence of respiratory infection, reduced mortality, increased resistance to adverse environmental conditions, as well as toxins in feed. Helps to increase the content of hemoglobin, beta-globulin and albumin in the blood. Stem cows humane used to improve the flow of childbirth, accelerate the separation of postpartum. Increases the weight of young cattle from 15 to 30%. In poultry farming increases the weight of 10 to 30%, egg production, the safety of chickens.

In addition, the humane helps to improve the safety of feed.

Methods of application and doses. Bio-preparation is used as an organic feed additive. Feed in two ways: in a mixture of mixed feeds / or as a solution for drinking.

Long burning ovens and ignition fuel

The main problem of burning hard coal is the high degree of gasification and a large amount of precipitation from the furnace heating. In order to improve the environmental situation, we have developed a pyrolysis furnace for long-term combustion. The furnace burns for more than a day on a bookmark of three buckets of coal. During this time it heats the dwelling and it is possible to prepare food on it. The temperature of the walls during this time reaches 550 g. Celsius.

The oven is at work. The temperature reaches 550 degrees centigrade

According to the protocols of the ecological expertise of Rostechnadzor, the MPC norms are 100 times lower than the norms. In order to save wood for burning furnaces, we have developed special tablets containing dry burning time of such tablets up to 40 minutes.

Oven ignition pills.

General type of production.

1. Effectiveness of the treatment of crops "Altaiskaya Wheat-92" by biologicals (work-study unit "Prigorodnoe")

Due to heavy precipitations, the timing for treatment had to be postponed. It was supposed to be in the period of tillering and had to be put off till the period of booting.

№	Variant	Crop Capacity center/ hectare	Crop Capacity Increase, center/ hectare	Weight of 1000 grains, gr	Gluten		Grain Type
					%	group	
1.	Control	12.2	-	37.16	13.6	1	low/gluten
2.	EAP 0.005% (2.5g/5 liters)	12.6	0.4	37.18	12.0	1	low/gluten
3.	EAP 0.01% (5g/5 liters)	13.4	1.2	37.65	12.0	1	low/gluten
4.	EAP 0.02% (10g/5 liters)	12.9	0.7	37.26	16.0	1	low/gluten
	P, %		2.14				
	$HCP_{05,}$ %		0.89				

Effectiveness of treatment of sugar beet with NAP and KCl (potash fertilizer) in the period of closure of two leaves (Topchikhinskiy area)

No	Variant due to schedule	Root capacity, ton/ hectare	Root capacity increase to controlled, ton/hect	Dry substanc, %	NO_3 content, microgram /kg	Sugar conten, %	Sugar collection, ton/ hectare	Sugar increase to controlled, ton/hect
1	**Absolute control**	**30.96**	**-**	**24.5**	**231.0**	**17.7**	**5.08**	**-**
2	NAP 0.005%	31.27	0.31	22.4	265.0	16.8	5.25	0.17
3	NAP 0.01%	38.02	7.06	23.6	304.0	16.8	6.38	1.30
4	NAP 0.02%	40.95	9.99	21.5	161.0	15.2	6.22	1.14
5	KCl 20kg/hect	32.85	1.89	22.3	326.0	18.1	5.94	0.86
6	NAP 0.0015%+ KCl 20kg/hect	38.92	7.96	23.1	143.0	19.1	7.43	2.35
7	NAP 0.02% + KCl 20kg/hect	38.25	7.29	25.8	143.0	20.0	7.65	2.57

2. Experiment with oats of a sort "Rovesnik" Table 4.4 Crop capacity data (center/hectare)

Variants due to schedule	Number of stems (m^2)	Indicators due to replication (center/hectare)			Average data due to variants	Increase, center / hectare
		1	2	3		
1.	289	31.0	32.6	33.6	32.4	
2.	269	31.6	32.1	30.0	31.2	-1.2
3.	283	31.6	33.3	33.6	32.8	0.4
4.	300	33.6	34.3	33.5	33.8	1.4
5.	373	40.8	42.6	41.3	41.6	9.2
6.	346	41.4	36.2	38.6	38.7	6.3
7.	339	35.9	40.6	38.4	38.3	5.9

Table 4.5
Quality of crops (for absolutely dry substance)

Variants due to schedule	N, %	P_2O_5, %	K_2O, %	Protein, %	Absolutely dry substance, %	1,000 grains, gr
1.	2.46	0.80	0.79	13.46	87.0	31.8
2.	2.72	0.79	0.86	15.73	87.2	31.9
3.	2.75	0.82	0.91	15.79	87.3	32.9
4.	2.79	0.82	0.77	16.02	87.3	33.1
5.	2.78	0.82	0.78	15.99	87.1	34.5
6.	2.61	0.83	0.80	15.02	87.5	34.1
7.	2.50	0.83	0.81	14.38	86.9	33.8

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