Trends of Seeds in the Era of Climate Change – an Issue of Concern towards Sustainability

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Abstract

Background/Objectives: India is an agro-based country where seed is the heartof agriculture. Agood quality seed makes a good crop resulting in high yield and better quality for better economic growth. The objective of the study is to explore the seed trends and critically assess the trends with the changing climatic conditions of Indian agriculture. **Methods/ Statistical Analysis**: The paper has undergone an exhaustive literature to find out the changing policies of agriculture seeds. The paper clearly shows that Seed can make agriculture sustainable. With time National Seeds Corporation have come up with several policies which has made promotion of agriculture convenient. The paper is based on secondary data obtained from ministry of agriculture and national seeds corporation. The study shows the trends in seed development since 1740 till 2014. Findings: The paper undergoes to concern issues of several research papers for making seeds sustainable in the era of climate change. The paper shows how the seeds policies have tried to adopt the seeds to climate change. These seeds policies have not only tried to improve the productivity of plants but also have tried to move the seeds towards the path of being sustainable. **Applications/Improvements:** This has been an issue of concern in modern era in terms of economic, environmental and social perspective leading to sustainability.

Keywords: Climate Change, National Seeds Corporation, Policy, Seeds, Sustainability

1. Introduction

India is an agro-based country where seed is the heart of agriculture. A good quality seed makes a good crop resulting in high yield and better quality for better economic growth. Ministry of Agriculture, Government of India acts as a nodal agency for agricultural activities all across India and is making significant contribution in Indian agriculture since long time. With the development of crops people realized the importance of the quality of seeds with time and save it from deterioration¹. With this National Seeds Corporation came into existence which undertook the function of production, processing and marketing of agriculture seeds.

National seeds corporation is indulged in protection of all varieties of seeds of all kinds of agricultural crops. The storage, grading and packaging is done by are then tested in laboratories located at New Delhi, Secunderabad, Pune, Bhopal and Kolkata. The seeds are tested in such a way that the quality and viability of the seeds are estimated with changing climate. The objectives of the study are to enlist the trends of the seeds policy in India and how the upcoming trends have led the seeds to survive in the unpredictable climatic conditions of India. The paper also comes out with some limitations in every seed policy which has led it to come with new trends. The current seed policy also has some limitations and needs some improvements in the era of climate change. The present paper explores the seedtrends and critically assess the trends with the changing climatic conditions of Indian agriculture. The paper is based on secondary data and comes up with some limitations in the present seed policy in regards to climate change. The Indian

technical machines which gives fine results. The seeds

seed industry comprises of a large number of private and public seed sectors. The public seed sectors comprises of a nodal agency National seeds corporation, State Farm Corporation and thirteen state seed corporations. All private and public seed sectors are responsible for storage of the seeds, seed multiplication and marketing of the seeds. All the public seed sectors work under the guidance of Indian Council of Agriculture Research and State Agriculture Universities².

2. National Seeds Corporation

National Seeds Corporation was established in 1963 and acts as a nodal agency for seed multiplication. Since time N.S.C has been working effectively for seed multiplication. It has produced numerous foundation seeds and certified seeds. It is responsible for proper storage of the seeds. The stored seeds undergo proper certification by crop inspection and labelling. Finally if the seeds are found unfit under proper testing such seeds are separated from the good seeds. The quality of seeds is maintained efficientlyandthe good quality seeds are graded and sorted properly through effective machines. The seeds are processed with proper handling and then packed for marketing. The seeds are distributed under proper sales promotion and communication. In order to make the seeds climate adapted, the seeds are tested for it's genotypes and it's resistance against drought and heat.

Several training programmes are given every year to the employees every year regarding Seed Quality Control, Hybrid Seed Production, Production and Marketing of Vegetable Seeds, Marketing of Seeds and Planting Materials, Seed Processing and their proper Storage.

3. Seed Production System in India

The seed development process in India is involved with multiplications of seeds giving rise to three types of seeds namely Breeder seeds, Foundation seeds and Certified seeds as presented in Table 1.

4. Role of Seed Development Programmes and Policies

One that is directly affected by the changing seeds policies is the farmer⁶. Framers are the ultimate victims of these seed policies. It was found that large farmers had an access to hybrid or breeder seeds while small farmers were restricted to low quality seeds since the price of high quality seeds was too high and the subsidies received was also very low. With time seeds policies began to change every year which acted as a supporting yardstick for the farmers. These seeds policies also acted as a beneficiary for the breeders. The seed policies which evolved since 1740 has been shown in the Table 2.

Seeds Type	Characteristics	Tag
Breeder Seeds	It is also called as nucleus seed because the seed is genetically pure produced by the breeder under I.C.A.R, State agriculture universities, state seed corporation, non-government organizations and KrishiVigyan Kendra. The production of breeder seed is evaluated by I.C.A.R- D.A.C in the seed review meeting held every year. These seeds are lifted directly for production of foundation seeds ³ .	Golden Yellow
Foundation Seeds	It is the progeny of breeders' seed entrusted by agriculture departments, private seed producers, state seed corporation, S.F.C.I and N.S.C. It must meet the standards of seed certification. This seed is tested at field and laboratory ⁴ .	White
Certified Seeds	It is the progeny of foundation seeds produced by state governments, S.S.C, Department of agriculture farms, cooperatives etc. This seed is then distributed to a number of channels at block and private agencies, village level, cooperatives and state seed corporations. The production of certified seed is done by farmers rowing under contract agreements in N.S.C. and S.S.C ⁵ .	Azar blue

Table 1. Characteristics of different types of seeds

Year	Characteristics	Research Work	Limitations
1740-1800	First company came into existence in horticulture crops.	A new beginning in the research world of agriculture.	There was no policies for seed multiplication
1850-1900	Plant Breeding emerged. First National Seed Association was established. Several companies developed for managing seeds of several crops.	Breeder seed known as the pure seed came into existence.	The climate was far better than today's so there was very little concern given to the climate.
1900	Public and Private seed sector began to evolve	Multiplication of seed was done on large scale	Government policies are of prime importance to public sector and neglected the private seed industry.
1963	Establishment of National Seeds Corporation		
1966	Enactment of seed act	Central Seed committee was established for seed testing, inspection, analysis and regulation	Some seed standards were required for scaling the seeds.
1968	Enactment of seed rules	Establishment of seed certification agency, seed analysis, marketing and labelling	
1970	Seed Industry expanded in number		
1972	Seed Amendment rules	Establishment of central seed board for seed certification. National Commission on Agriculture's seed group also came into existence	
1973	Seed Amendment Rules	Seed testing manual were published by I.C.A.R	
1974	Seed amendment rule	Main priority is given to seed inspection	
1975-80	Launching of the World Bank aided National Seeds Programme in three phases leading to the creation of State Seeds Corporation, State Seed Certification agencies, State Seed Testing Laboratories, Breeder Seed Programmes etc.		
1980	Private seed companies entered the market		Private seed companies mainly focused on hybrid seeds
1981	Seed amendment rules	A minimum seed certification standard was developed	
1983	Seed Control Order	The licence were provided to seed dealers valid for 3 years	There was misrepresentation of licence.
1986	Establishment of Biotechnology	This led to application of biotechnology in agriculture. Creation of the Technology Mission on Oilseeds & Pulses now called The Integrated Scheme of oilseeds, pulses oilpalm and maize. Production and distribution of subsidy and seed minkits	

Table 2. Trends in the seeds since 1740

1988	The New Seeds Policy	The policy was on seed development to provide easy access to farmers for better quality seeds.	There was no protection of breeders right.
1989	Plants, fruits and seed order	The import of seeds were regulated	
1991	Multinational companies were attracted to India's seed market		India's own seed policy needed a lot of improvements
2001	Protection of Plant variety and farmer's right	Seed must be protected by intellectual property rights	
2002	National Seeds Policy	National seed research centres were established to make Indian seeds as global. Variety development, plant variety development, seeds development, quality assurance, seed distribution and marketing, infrastructure facilities, transgenic plant varieties, import and export of seeds and promotion of private sector seed industry.	
2003	Protection of plant variety rules	The rule was implemented for the effective protection of plant variety	The registration of seed was not in a regular flow.
2004	Seed bill ⁷	Registration of seed was made compulsory. All kinds of seeds were registered, their evaluation, seed analysis, testing, certification, export and import of seeds.	
2005	Formulation of National Seed Plan		
2007	Fiscal Act		
2007	National food Security		
2007	National Food Security Mission RashtriyaKrishiVikasYojna	To maximise farmer's return promoting agriculture.	

Table 3. Comparative structure of private and public sectors

Public Sector	Public Sector
The Private sector has increased it's role since last few years and the number of companies engaged in private companies has also increased tremendously	The Public sector still has a major role in the production of high quality seeds of cereals, pulses and oilseeds.
This sector focus on production of hybrid seeds	It is dominant in the production of seeds of oilseeds, cereals and pulses for many years
It has a major share in the production of seeds of maize, sunflower and cotton ⁸ .	The public seed sector has 15 state seed corporation and 2 national level seed corporations namely national seeds corporation and state farm corporation
Such firms are heterogenous ⁹ .	Such firms are homogenous
Private seed sector is dominant in production of vegetables and horticulture	

5. Role of Public and Private Seed Sector

Private and public seed sectors play a major role in seed development. The Table 3 gives a comparative picture of private and public seed sectors. The seed sectors in private and public sectors have encouraged seeds viability. Private sector has a major share in seed production and has improved the trends of the upcoming seeds.

6. Variety Registration

The registration of a new variety undergoes three steps for seed evaluation:

- The reaction of the varieties to several diseases is studied by pathologists through testing in Initial Yield Evaluation Trial.
- Then the samples are tested in large locations in large zones fordisease, pests and the traits are studied. This type of test is known as uniform regional trials.
- A number of scientists are accumulated in a workshop and the proposal to release a variety is discussed on the basis of the tests.

7. Protection of Variety in India

Plant protection variety and farmer's right came in existence in 2001 with the objective to encourage high quality seeds, protecting the farmers who try to make available all kinds of resources for development of a new variety leading to development of agriculture.

Many intellectual property rights like patents and copyrights are provided to the breeders to protect the novelty, distinctness and stability of their seeds. Such rights are provided to persons who are breeders or assigned to be a breeder, any university and farmers who claim as a breeder of any particular variety of a crop.

8. Seed Certification System

In seed multiplication and production it is very necessary to have a check on the quality control. For this a legal sanctioned system came into existence known as the seed certification system. The seed certification started in the 20th century. The Table 4 given below shows the evolution of seed certification. It were the Swedish workers who first initiated seed testing. With time scientists started working and then field testing came into evolution.

The seed certification system consists of some minimum certification standards under which seeds are evaluated and their acceptance as well as rejection depends upon these standards. The seeds are tested for their texture, size, texture, moisture percentage, germination percentage, viability and other parameters. Since seeds are very sensitive creature of nature and has to be handled with great care as the yield of a crop is largely dependent on the seeds from which it has been generated.

The seed certification came up with the minimum standards of seed regarding quality and purity. The objectives of seed certification are develop genetically pure seeds and to develop viable seeds. Seed certification requires general, field standards and seed certification agencies. The seed certification involves six phases and involved field inspection, seed processing, seed labelling, seed testing and seed control. In the first phase of the seed certise of the seed cer dependent on the seeds from which it has been generated. great care as the yield oisture percentage, germinfication seeds are verified on the basis of it's texture, size and type. Then in the second phase seeds are sent for application where the seeds are grown for testing their quality. After that the seeds are inspected regarding the minimum seed certification standards evolved by breeders. After the inspection of seeds they are sent for sample analysis. After successful results these seeds are processed and packed. Lastly a certificate is issued with a tag to the seeds which consist of the characteristics of the seeds¹¹ as shown in Figure 1.

Table 4. History of seed certification

Year	Trends of seed certification
20 th centuary	Evolution of the idea of seed certification. Swedish workers were the first to initiate seed testing.
1919	Scientists of the USA and Canada held a meeting to form an International crop improvement association
1963	Field testing started from N.S.C
1966	First Indian seed act was established10.
1968	Seed rules came into existence
1969	Association of official seed certification agencies



Figure 1. Six Phase of Seed Certification

9. Seed Export and Import

EXIM policy of 2002-2007 has promoted export and import of seed all over the world. It has removed restrictions on export of seed varieties. Seed which are imported are given to ICAR for evaluation in one season. The EXIM policy is regulated under plant quarantine order of 2003.

10. Seeds towards Sustainability in the Era of Climate Change

In the era of climate change there are policies for adopting the seeds to retain the diversity of the seeds. The collection of seeds must include a number of genotypes for each species. National Seeds Corporation stores seeds as buffer stock for supplying the seeds during uncertainties of climate change. Irrespective of the climate change, the population of the country is increasing day to day while the foods are inadequate. Therefore, seeds must be provided with proper care in order to protect them from climate change. New crop varieties and seed banks must be introduced to fulfil the demands for food in the coming future. The diversity of seeds must be encouraged by providing several opportunities to the farmers to face the challenges of climatic change. Due to population rise, pollution control has also become a major cause of concern. The increase population has resulted into global warming and drastic climate change.

According to meteorology, the year 2014 has been the hottest year of the earth. Now the problem arises how to save the seeds from such high temperatures. Taking this as a major issue, Indian Council of Agriculture Research has been trying to convey the message to the farmers for growing crops which are resistant to drought and heat. National Seeds Corporation has been trying to store such seeds to make it easily available to the farmers. Plant breeders have adopted management practices for their seeds to increase the self-life of the seed. According to state seeds corporation, the approximate life of the seed is 6 months to 2 years. Government has been providing irrigation facilities to the farmers to reduce the dependency on rainfall. In the era of climate change, breeders are trying hard to produce such seeds which can face the threats of climate change. Today the major problem lies in the management of such seeds to have a better crop. Many practices such as tillage, contouring, terracing, bands, green house and many others have been adopted to protectthe crops from erosion and retain the moisture level.

Several policies regarding climate adaptation are encouraged. A variety of crops and seed banks must be introduced. Management practices should be developed, seeds which are resistant to drought and heat must be promoted. Many workshops has been introduced to develop a model of climate on the seeds. The impact of climate on the seeds must be introduced in the seed policy itself ¹². Storing seeds are done by all the seed banks but the genotypes become infeasible. Seed banks are found to beinsufficient to retain the genotypes¹³. According to ISU seed testing laboratory before variety releases seed has to undergo several tests like germination tests which determines the germination capacity of seed during cold or hot temperatures. Accelerated Aging: This is done for estimating the seedlings in the field. Tetrazolium test: Under this test a seeds are placed in the tetrazolium solutions to detect the damages or problems of the seed lot due to flood, frost or other calamities. There are several other tests like herbicides bioassay, fast green, polymerase chain reaction and immunoassay for seed testing in order to make the seeds adopted to climate change¹⁴.

The seeds of Kharif crops are sown in the month of July which requires a good rainfall. Due to climate change there is spatial and temporal variations in rainfall which ultimately affects the crops. Lack of erratic rainfall results in lower underground water table which leads to reduce the carbon content of the soil making it easier for the pests to survive. Delay in the monsoon season results in low rainfall, less water storage and availability of water for irrigation. This has resulted into shift in the sowing dates of the kharif crops and rescheduling of water and nutrients. Delay in sowing of kharif crops results in late harvesting of crops and again late sowing of rabi crops¹⁵. The unpredictable rainfall in rabi season leaves an impact on critical grain crops. Low availability of water and high temperatures results in low productivity of crops. In the era of climate change water shortage has become problematic for agriculture¹⁶. Blue water is the indicator of rivers, lakes, ponds and aquifers which is the main source of irrigation for crops. Rain water constitutes of oxides of nitrous and sulphur (acid rain) or constituents of salt with some trace elements of pollutants which again deteriorates the seeds or affects the nutritional content of the crops. The salinity can be destroyed by irrigation which maintains the fertility of the soil¹⁶.

Today the major issue of concern is the evil impacts of climate change on agriculture and the evil impacts of agricultural and water practices to climate change. This must be dealt through in order to attain sustainability. The reason for increasing global warming is not just pollution but also the agricultural practices which though increases the yield but is leaving an adverse impact on climate. According to Richard M. Adam et al. climate changes strongly affects the yield of the agricultural crops. High temperatures leads to low yield and high yield variances while high precipitation leads to high yield and reduces the variability.

11. Conclusion

The changing trends in seed policy have done a great job in the seed industry. The seed policies have led to the development of genetically pure seeds. These policies have led the seed to undergo several tests before being registered as a variety. With time breeders are now provided with intellectual property rights which have led to maintain the novelty, stability, distinctness and uniformity of the seed. Seed is the most critical part of the crop and for developing a sustainable agriculture it is very important to develop a good seed. Seed leads to a sustainable agriculture¹⁷. Seed must be protected from pests, diseases and weeds. The seed policy leads to variety development and improvement of seeds. This has resulted into increase in the production of breeder seeds. The national seeds corporation came up in 1963 with the aim to protect the seeds from deterioration. It is responsible for seed marketing, promotion and distribution. Indian agriculture has a huge amount of crops and several researches are still going on to improve the agriculture scenario. The seed

certification has an important role in seed industry. It has led to minimum seed standards which have resulted into pure and viable seeds. With time seeds have been found efficient to adapt themselves in the climate change¹⁸.

Seed policy must be implemented effectively because ineffective implementation of seed policy results in low production of pure seeds, poor seed certification standards and poor distribution of seeds. Private seed companies have promoted seed sector to a high level but has certain limitations. They have high risks with high costs. There is lack of credit facilities in seed sector which has resulted into poor demand of seeds. The variety control system has resulted into the limitations of new varieties¹⁹ which is again a matter of concern for the climate adaptation. Comparing private sector with public, the government provides subsidies which leads to poor promotion of private seeds. The agencies have poorly implemented the seed certification standards.

Based on the findingsfrom secondary data, an effective implementation of seed policy must be there regarding climate change²⁰. The production of breeder seeds must be increased. Measures should be developed to encourage private seed companies. Sustainability of seeds should be given major concern. There should be further research for determining demand and supply of seeds. Seed farmer groups should be formulated for marketing at state levels.

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13.References

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