REVIEW ARTICLE Agricultural Reviews, Volume 45 Issue 1: 89-95 (March 2024)

Indian Seed Legislation and Effect of Covid-19 on Seed Industry: A Review

S. Rajendra Prasad[1], K.D. Rajatha[2], V.K. Surabhi[2], K. Uma Rani[2]

10.18805/ag.R-2340

ABSTRACT

Indian seed industry has shown an annual growth rate of 15.7% during 2011-2018 and is further expected to grow at a CAGR of 13.6% during 2019-2024, reaching a value of US $ 9.1 Billion by 2024. For any seed system to be viable and sustainable it requires a great deal of efforts through the right kind of laws, acts and policy framework and interventions as its essential pre-requisites. Due implementation of some progressive policies by the government of India, seed market has witnessed a major restructuring. These policies bought relaxed seed trade norms, reduced import restrictions on germplasm, encouraged foreign investments, supported quality seed production, plant variety protection, farmers and breeders right protection. Covid-19 pandemic and restrictions imposed had tremendous impact on the seed industry. The policy response and initiatives taken up by the government to address the problems by adopting various strategies helped in the uplifting the farming community. By classifying agriculture sector as essential, it eased in the continuous movement of the seed. This review gives insight about how the Indian seed legislation helped to increase the growth rate of Indian seed industry and also impact of covid-19 pandemic on seed sector.

Key words: Act, Bill, Covid-19, Legislation, Policy, Seed industry.

Global demand for agricultural crops is increasing and may continue to do so for decades, propelled by a 2.3 billion person increase in global population and greater per capita incomes anticipated through mid-century (Godfray *et al.,* 2010). Therefore, in order to increase the quantity and quality of produce, efforts are made to introduce enhanced varieties of seeds with the help of advance technology and modern agricultural methods. The peer reviewed estimate (Tilman *et al.,* 2011) suggests that crop demand may increase by 100 % to 110 % between 2005 and 2050. Numerous authors have suggested that increasing crop yields, s as plant propagules (Ajayi, 2007). Technology has refashioned much of farming's day-to-day operations, but without an unwavering supply of high-quality seeds productivity and quality would appreciably be decreased. Seed as a carrier of new technology augmented with seed quality alone contributes to productivity by more than 20 per cent and quality seed is a chief factor to ensure the food security as it decides the future of the plant. The introduction of high yielding, semi-dwarf fertilizer responsive varieties of wheat and rice in addition to discernible progress made in quality seed production together with an improved seed-distribution system, enabled dramatic shift from "food scarce" to "food secure" status in the country. From a predominantly public sector producing varieties suited for Green Revolution agriculture in the 1960's, the Indian seed industry has evolved into a multi-faceted industry with a large involvement of private firms and increasing emphasis on research and development. This success was the result of holy alliance between policy makers/administrators and the hard working farmers (Singh *et al.,* 2019). Thus, Indian seed market has witnessed a major restructuring as a result of the implementation of some progressive policies by the government *viz*., The Essential Commodities Act (1955), The Seeds Act (1966), The Seed (Control) Order 1983, New Seed Policy (1988), National Seed Policy (2002), PPV and FR Act (2001), EXIM Policy (2002), Agricultural Produce Market Committee (2003) Act and The draft seed bill (2019) (Fig 1 and Table1).

[1]Department of Seed Science and Technology, Gandhi Krishi Vigyan Kendra, University of Agricultural Sciences, Bangalore-560 065, Karnataka, India.

[2]National Seed Project, Gandhi Krishi Vigyan Kendra, University of Agricultural Sciences, Bangalore-560 065, Karnataka, India.

Corresponding Author: K.D. Rajatha, National Seed Project, Gandhi Krishi Vigyan Kendra, University of Agricultural Sciences, Bangalore-560 065, Karnataka, India. Email: rajathakd@gmail.com

How to cite this article: Prasad, S.R., Rajatha, K.D., Surabhi, V.K. and Uma Rani, K. (2024). Indian Seed Legislation and Effect of Covid-19 on Seed Industry: A Review. Agricultural Reviews. 45(1): 89-95. doi: 10.18805/ag.R-2340.

Submitted: 03-08-2021 **Accepted:** 10-02-2022 **Online:** 28-03-2022

Seed production systems and supply chain in India

There are two types of seed system which are prevalent in India, *i.e.* informal and formal. Formal seed system involves a chain of activities leading to clear products. Informal system (contributes about 65%), also known as village or farmer or local seed system, farmers themselves produce, disseminate and access seed directly from their own harvest, through exchange among friends, neighbours and relatives or through local grain markets. The varieties disseminated may be landrace or mixed races and likely to be heterogeneous mixture of different varieties. Formal system (contributes about 35%) generally consists of public sector research institutions, public and private sector agencies

producing and marketing seeds, agencies responsible for seed certification and quality control. The guiding principles in the formal system are maintenance of varietal identity, genetic purity and production of seed with optimal physical, physiological and sanitary quality (DAC and FW, 2015-16). Formal seed system have some of the limitations that has to be addressed like difficulty in meeting the needs of small farmers in marginal areas, unable to meet the huge demand of seeds especially of legumes and oilseeds by public sectors, overlook of small farmers in remote rural areas due to poor logistics in seed diffusion, reluctance of private sector to produce seeds of pure line varieties of high volume- low value crops and prohibitive seed prices. Some of the drawbacks of informal seed system include lack of maintenance of varietal integrity and genetic purity leading to sub-optimal seed quality, restriction of seed exchange to a geographical area and governed by cultural barriers, effect on availability of seeds due to crop failures or low yields, low yield potential of most landraces and traditional varieties and slow paced dissemination of technology (Lohr *et al.,* 2015).

Making seed available to the end-users at the right time and place requires an integrated seed supply system combing both formal and informal including local seed supply system. This could be achieved through combined efforts of Department of Agriculture, State Agricultural Universities, ICAR institutes, Krishi Vigyan Kendras, State Seeds Corporation, National Seeds Corporation, State Farms Corporation of India, State Seeds Certification Agencies, Non-Governmental Organizations, Private seed industries, Self-help groups and Farmer Producer Organization.

Policy, bill and act

Legislative proposals are brought before either house of the Parliament of India in the form of a bill. A bill is the draft of a legislative proposal, which, when passed by both houses of Parliament and assented to by the President, becomes an Act of Parliament. As soon as the bill has been framed, it has to be published in the newspapers and the general public is asked to comment in a democratic manner. The bill may then be amended to incorporate the public opinion in a constructive manner and then may be introduced in the Parliament by ministers or private members.

A policy is a statement of intent and is implemented as a procedure or protocol. Policies are generally adopted by a governance body within an organization. Policies can assist in both subjective and objective decision making. The term may apply to government, private sector organizations and groups, as well as individuals. Presidential executive orders, corporate privacy policies and parliamentary rules of order are all examples of policy. Policy differs from rules or law. While law can compel or prohibit behaviours, policy merely guides actions toward those that are most likely to achieve a desired outcome.

Historical perspective

The expansion of seed industry has occurred in parallel with growth in agricultural productivity. Given the fact that sustained growth to cope with increasing demand would depends more and more on the pace of development and adoption of innovative technologies, the seed would continue to be a vital component for decades to come. The organized seed industry of the country is just forty years old. Yet, its growth has been phenomenal. India is one of the few countries where the seed sector is already reasonably advanced. The private seed industry is no more confined to just production and marketing of seed. It has as well acquired technological strength to cater to the varietal needs of tomorrow (Gadwal, 2003). In India, agriculture is the dominant occupation, which secures abundant opportunities for the seed market; India has emerged as the fifth largest seed market across the globe. The Indian seeds market reached a value of US$ 4.1 Billion in 2018, exhibiting a Compound annual growth rate of 15.7% during 2011-2018 (Source: IMARC groups, Indian Seed sector analysis: growth, trends and forecast (2019-2024). Indian seed industry is accounting for 4.4% of global seed market after the U.S. (27%), China (20%), France (8%) and Brazil (6%). In the significant advances that India made in agriculture in the last four decades, the role of the seed sector has been substantial. In its initial stage, the Indian seed industry consisted primarily of two national organizations.

The Organization for Economic Co-operation and Development (OECD) an intergovernmental organization founded in 1958, Secretariat at Paris (France) provides a multilateral forum to discuss, develop and reform economic and social policies. The OECD Seed Schemes provide an international framework for the certification of agriculture seed moving in international trade. Including India, 58 countries from Europe, North and South America, the Middle-East, Asia and Oceania currently participation in the OECD Seed Schemes. The main objectives of OECD seed schemes are the varietal certification of seed are to encourage the use of “quality-guaranteed” seed in participating countries. The Schemes authorize the use of labels and certificates for seed produced and processed for international trade according to agreed principles ensuring identify and purity. The Schemes facilitate the import and export of seed, by the removal of technical trade barriers through internationally recognized labels (passports for trade). They also lay down guidelines for seed multiplication abroad as well as for the delegation of some control activities to the private sector (accreditation). The National Seeds Corporation was established in 1963 and for about 13 years, it was the main organization in charge of the production and marketing of commercial seeds, it was assisted by the Rockefeller Foundation and USAID in its mission of quality control and training in seed production. A second national agency, the States Farms Corporation of India Limited (SFCL), was formed in 1969 with the mandate of producing breeder, foundation and certified seeds of high yielding varieties.

The Government of India enacted the Seeds Act in 1966 to regulate the growing seed industry. The sixties were the most eventful times for Indian agriculture, not only because of introduction of high-yielding cereals, but also for many other positive developments related to seed such as, constitution of Seed Review Team, enactment of Seeds Act, 1966 and formation of National Commission on Agriculture. World Bank launched a funding project *i.e.* The National Seed Project (NSP) which was implemented in three phases *viz.,* Phase I (1977-78), Phase II (1978-79) and Phase III (1990-91). Under these projects initially nine State Seed Corporations (15 at present), State Seed Certification Agencies (22 at present), State Seed Testing Laboratories were established and Breeder Seed Programme were also under taken (Singh *et al*., 2019). New Policy on Seed Development, 1988 was formulated to provide Indian farmers with access to the best available seeds and planting materials of domestic as well as imported, made a revolution in Indian seed industry by liberalizing the seed trade and made Indian farmers to access best quality seed or planting material from abroad the world. PPV and FRA (Protection of Plant Varieties and Farmers Rights Act) in 2001 provides farmers the right to save, use exchange, share and sell farm produce of protected variety except sale of branded seed. But these legislative systems helped to reach farmers high quality seeds which in turn supported seed industry growth in India. Thus, the brief detailed milestone of Indian seed legalisation is given below (Table 1 and Fig 1).

Table 1: Milestones in Indian seed legislation.

Year	Event
1928	Report of Royal Commission on Agriculture
1955	Essential Commodity Act
1966	The Seeds Act
1968	The Seed Rules
1983	The Seed (Control) Order
1986	The Environmental Act
1988	New Policy on Seed
1989	The Plants Fruits and Seeds (Regulation of import into India) order
2001	The Protection of Plant Varieties and Farmers Right Act
2002	The Biological Diversity Act
2002	National Seed Policy
2002-2007	EXIM policy on seeds
2003	The Protection of Plant Varieties and Farmers Right Rules
2004	Biological Diversity Rules
2019	The Draft Seeds Bill

Essential Commodity Act 1955

It is an Act to provide, in the interest of the general public, for the control of the production, supply and distribution of and trade and commerce, in certain commodities.

The essential commodity act was enacted way back in 1955. It provides a legislation system to regulate the production supply and distribution of a huge amount of commodities, it declares “essential” in order to make them available to consumer at fair prices. The list of the items under the act includes drugs, fertilisers, pulses, seeds etc. The government can include new commodities as and when the need arises and also takes them off the list once the situation improves.

The Seeds Act 1966

An act to provide for regulating the quality of certain seeds for sale and for matters connected therewith.

The seeds act was formulated in 1963 and the parliament had passed the Seeds Act 1966 to provide legal framework around seed certification and make good quality seeds available to the cultivators. The Seeds Act 1966 has total 25 clauses. Seeds of food crops, oil crops, cotton seeds, seeds of cattle fodder and all types of vegetative propagating material are included. Under this act Seed rules were framed

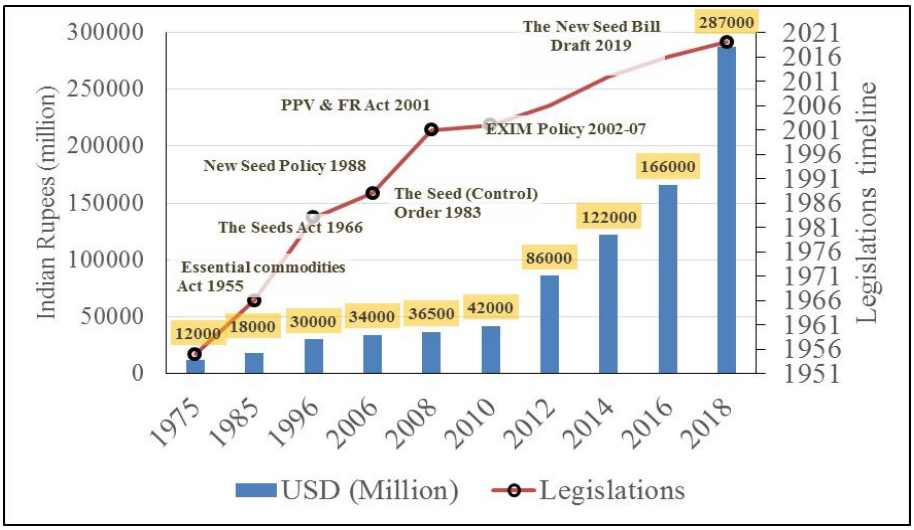


Fig 1: Growth pattern of Indian Seed Business along with the implementation of seed policies.
Source: ICARD, ISF and IACG.

and notified in 1968 and systematic Seed Certification started in India in 1969.

This act provided for establishment of a Central Seed Committee to advise the states in seed related matters. It also provided for establishment of Seed Certification Agencies in the states; Seed certification Boards and State Seed Testing Laboratories. Its important features are; seeds should contain specific seed standards, which include stipulated minimum physical and genetic purity, seed germination percentage and not exceeding the maximum permissible limit of off-types and weed seeds for notified seeds. The seeds should be tagged either by compulsory labelling or voluntary certification through independent State Seed Certification Agencies which were placed under the control of state departments of agriculture.

Some of the constraints of the present Seeds Act 1966 include policy issues where the seed sectors are not motivated enough to supply quality seeds on a large scale at affordable price; selling of low quality seeds by the seed companies to the farmers as Act is applicable only after the seeds are packed for selling where seed production is not covered under the existing act; as labelling is compulsory and certification is voluntary, the seed companies sell their produce as truthfully labelled seeds and thus not undergo the process of certification; lack of regulation on agriculture and horticulture nurseries; law is applicable only for notified variety; lack of licensing and varietal registration provisions prior to sale. With this backdrop the draft Seed Bill 2019 was proposed with the aim of reforming the Seeds Act 1966.

The Seed (Control) Order, 1983

The inclusion of seeds as an essential commodity item under the Essential Commodity Act, 1955 brought the Seeds (Control) Order.

This order states that a person carrying on the business of selling, exporting and importing of seeds needs to obtain a license. The Essential Commodity Act, 1955 gives powers to state governments to regulate various aspects of trading in essential commodities under the supervision of Central Government (Santhy *et al.,* 2001). The license provided to a seed dealer remains valid only for 3 years from the date of its issue which can be later renewed but the Seeds (Control) Amendment Order, 2019 in clause 6 the license can be valid till "five years".

New Seed Policy 1988

The Government of India evolved a New Seed Policy implemented from October 1, 1988. This led to significant changes in the structure and regulation of the country's seed industry. The policy permits the import of selected seeds under Open General License (OGL), to make available to farmers high quality seeds to maximize yield, increase productivity thereby farm income. The policy allow import under OGL of items such as seeds of oilseed crops, pulses, coarse grains, vegetables, flowers, ornamental plants, tubers, bulbs, cuttings and saplings of flowers. Private seed producing firms should compulsorily register with NSC before importing the seeds.

The Protection of Plant Varieties and Farmers' Rights (PPV&FR) Act, 2001

The existing Indian Patent Act, 1970 excluded agriculture and horticultural methods of production from patentability. The sui generis system for protection of plant varieties was developed integrating the rights of breeders, farmers and village communities and taking care of the concerns for equitable sharing of benefits (Brahmi *et al.,* 2004)

In order to provide for the establishment of an effective system for the protection of plant varieties, the rights of farmers and plant breeders and to encourage the development of new varieties of plants it has been considered necessary to recognize and to protect the rights of the farmers in respect of their contributions made at any time in conserving, improving and making available plant genetic resources for the development of new plant varieties. The Govt. of India enacted "The Protection of Plant Varieties and Farmers' Rights (PPV and FR) Act, 2001" adopting sui generis system (Ravishankar *et al.,* 2000). The main objectives of the act were to establish an effective system for the protection of plant varieties, the rights of farmers and plant breeders and to encourage the development of new varieties of plants. To recognize and protect the rights of farmers in respect of their contributions made at any time in conserving, improving and making available plant genetic resources for the development of new plant varieties. To accelerate agricultural development in the country, protect plant breeders' rights; stimulate investment for research and development both in public and private sector for the development new of plant varieties. Facilitate the growth of seed industry in the country which will ensure the availability of high quality seeds and planting material to the farmers. The act covers all categories of plants, except microorganisms (Brahmi *et al.,* 2004).

National Seed Policy 2002

National seed policy was formulated in 2002, the policy is primarily aimed to boost investment in research and development in new plant varieties by providing IPR and to raise India's' share in the global seed trade by facilitating advanced scientific aspects such as biotechnology to farmers and in March 2002, first transgenic *Bt* cotton was approved for commercial cultivation in India. Promote seed village scheme to increase the production and make available the seeds in time as well as upgrading the quality of farmers' saved seeds. Establishment of seed banks for ensuring supply in times of calamity and storage facility at village level.

Export-import policy 2002-07

In exercise of the powers conferred under Section 5 of the Foreign Trade (Development and Regulation Act), 1992, the Central Government hereby notifies the Export and Import Policy for the period 2002-2007. Quantitative Restrictions

(QRs) on exports have been withdrawn except on a few items relating to national security. The main objective of the Government's EXIM Policy is to promote exports to the maximum extent. Exports should be promoted in such, a manner that the economy of the country is not affected by unregulated exports of items specially needed within the country.

The Draft Seed Bill 2019

To provide for regulating the quality of seeds for sale, import and export and to facilitate production and supply of seeds of quality and for matters connected therewith or incidental thereto.

The Seeds Bill 2004 was introduced in Rajya Sabha on 9th December 2004 and has been referred to the Standing committee on agriculture. This bill if it comes into force will replace Seeds Act, 1966 and Seed Control Order 1983. Some of the salient features include (The Hindu Newspaper, 2019).

The Bill authorizes the Central government to reconstitute a Central Seed Committee. All varieties of seeds for sale have to be registered [Currently, a large percentage of seed is sold under a self-certification programme called *Truthfully Labelled* (TL) seeds] and are required to meet certain prescribed minimum standards. For instance, for transgenic varieties of seeds, registration is to be obtained under the Environment (Protection) Act, 1986. Farmers are exempted from obtaining registration for varieties developed by them. But if the farmer sells such seeds for a monetary consideration, then that sale needs to be registered. Farmers are allowed to sow, exchange or sell their farm seeds and planting material without having to conform to the prescribed minimum limits of germination, physical purity and genetic purity (Gopakumar and Saxena, 2005). However, farmers cannot sell any seed under a brand name. The bill has proposed a differentiation between the seed producer, seed processor and seed dealer for the purpose of licensing. However, there is no recognition of National Level Integrated Seed Companies with R&D capabilities. Licences/ registration of fruit nurseries. Bill empowers the government to fix prices of selected varieties in case of "emergent situations" such as seed shortage, abnormal increase in price, monopolistic pricing, profiteering *etc*. Consumer Protection Act, 1986 to be used to deal with complaints related to the non-performance of seed. Bill differentiates the agronomic performance of the seed, its physical quality and the supply of spurious seed and consequently penalizes the offences and prescribes punishment.

The Draft of the Seeds Bill 2004 has been revised four times 2010, 2011, 2014 and 2019 since its first introduction in 2004 to accommodate some of the concerns expressed by farmer's bodies, civil society and parliamentarians include dependency of the farmers on seed companies and deprived of their right to cultivate and propagate the indigenous seeds; seed companies have opposed the price control of seeds as it will stifle innovation and result in a scale back of research investments; compulsory registration of seeds; the bill proposes registration/ licences for seed companies, seed processing plants, seed producers, seed dealers and nurseries (Kaundinya, 2019).

Impact of Covid-19 induced lockdown on seed industry

The lockdown in the wake of Covid-19 which was declared as a pandemic by the WHO had put many countries under tight spot disrupting the daily activities. The Organization for Economic Co-operation and Development (OCED) forecasted decrease in economic growth from 2.9% to 2.4% in 2020 and also warned that, economic growth may also reach nearly 1.5% if the pandemic is prolonged (OECD, 2020). The restrictions imposed by the governments to curb the spread had a huge impact on economic sectors such as agriculture which provides for food security and human development. According to International Labour Organisation, out of total employer population in 2019, 26.85% of employers are in agricultural sector (World Bank, 2019).

Agriculture being the primary source of livelihood for over 58% of the nation's population and provide employment for 44% of the workforce is a prominent sector of Indian economy contributing approximately 17.2% to the GDP. Several agricultural activities were hit result of shortage of labour due to reverse migration affecting harvesting of crops, transportation and distribution (FICCI, 2020). Different agriculture sectors like seed industry, crop production, livestock and fishery have been hit hard by the pandemic. Due to travel restrictions imposed farmers faced the shortage of basic inputs like seeds, fertilizer and pesticides.

Global seed industry faced serious impact with disorganized production, processing, certification, transportation and distribution of seeds. The restrictions imposed by the governments to curb the spread had a huge impact on seed industry and farmers preparing for the upcoming *kharif* season. India alone needs 250 lakh quintals of seed for crop production in *kharif* season (Singh, 2020). The onset of pandemic delayed the *Rabi* crop harvest and disrupted the availability of seeds for *kharif* sowing. It was discovered that 10% of the farmers in India did not reap their yield due to lockdown, low market cost and inaccessibility of transportation leading to putting away the yields instead of selling and the seed industry saw a drop of 15-20% due to disruption in supply chain (Kumar *et al.,* 2021). Initial estimates suggest that 30% of the cotton and maize hybrid seeds replacement market was lost for the *kharif* season (FICCI, 2020).

Major threats faced by the seed stakeholders (FICCI, 2020)

Seed companies faced difficulties in execution of contracts with small and marginal farmers involved in hybrid seed production due to social distancing, labour shortage and transportation restriction.

- Small and marginal farmers in remote places faced delays in seed supply.
- Disruptions in road, air and water transport impacted the movement of seeds to markets during the lockdown.

• Seed quality was compromised due to delay in harvesting due to labour shortage and also restriction on operations of testing labs.

To overcome these possible threats, it makes sense to adopt several strategies like helping the farmers save the seeds by providing information on seed storage, better seed selection, rigorous remote informal market assessment especially for the informal market; adopt approaches like direct seed distribution by procurement of quality seed, usually from outside the agro-ecological region, for subsequent free delivery to farmers; Advocacy for relaxed quality restrictions allowing for more supplies (Sperling, 2020).

Possible steps to strengthen seed sector during Covid-19 crisis (FICCI, 2020)

Empowerment of Farmer Producer Organization to aggregate the farm seeds to be processed further and buy in bulk directly from the manufacturer. This can also help with local mobility ensuring social distancing.

- As most of the seed is produced in India, except for some vegetable seeds (cabbage, cauliflower and cucurbits), it has the potential to be developed as a major seed export hub.
- Incentivise companies to further invest in research and development of more resilient and efficient seed varieties.
- Bulk hybrid seed imports should be allowed for export purposes to aid in increase of farmer income.

For the uplift of the economy during the Covid-19 crisis the government of India announced the Atmanirbhar Bharat Abhiyan (self-reliant India initiative) which also focused on the agriculture sector. The several measures announced favouring agricultural and allied activities include strengthening infrastructure, logistics, governance and administrative reforms. The prime minister highlighted the ability to turn this crisis into an opportunity for the country by 'going vocal for local'- reinventing the domestic agriculture supply chain to meet local as well as global demand. Some requirements of the industry have been addressed in the financial stimulus package (FICCI, 2020):

1. The proposed amendment in the Essential Commodities Act and revision of the APMC law will enable farmers to get the best price for their produce, be it local, national, or global markets.
2. The INR 1 lakh crore agro infrastructure funds will help in strengthening farm gate infrastructure for farmers and benefit both supply and demand.
3. The provision of INR 50,000 crore for animal husbandry and fishery will enhance the scope for alternate income avenues for rural population.
4. The INR 10,000 crore scheme for the formalisation of micro food enterprises (MFE) and the cluster-based approach will help in building capacity at regional levels and better supply chain integration.
5. Extension of Operation Green to all fruits and vegetables will enable farmers to diversify their produce and add much needed quicker cash generation, which comes with shorter sales cycles of fruits and vegetables.
6. Several additional and emergency working capital funding schemes have been announced to improve the liquidity with the farmers.

Indian start-ups and innovators will play a vital role in the success of the mission. The Atma Nirbhar Bharat Abhiyan is a chance for Indian start-ups to take charge of the innovations for which we are usually dependent on global suppliers. They can lead the way by innovating and bringing to market products and services that are world-class yet affordable. Start-ups in sectors like agriculture, automation, fin-tech, supply chain, logistics, healthcare, *etc*. would lead the charge in the mission.

Agri War Room to assist farmers during Covid-19 in Karnataka

To restore agricultural operations during the lockdown in the state, the Agriculture Department and all the state Agricultural Universities launched an "Agri War Room" to attend to the problems of farmers and other stakeholders. The initiation was taken up to resolve the problems in getting fertilizers, pesticides, farm implements, seeds and other inputs. Steps were taken to ensure that all the service providers, including shopkeepers to open their sales units in various districts by providing them with 'green passes' and also to the farmers for marketing of their produce during the lockdown. Helpline numbers were also operated to attend to the problems of the farmers (Kumar, 2020).

Conflict of interest

All authors declared that there is no conflict of interest.

REFERENCES

Ajayi, S.A. (2007). Current trends in seed science: Implications for sub-Saharan Africa. African Crop Science Conference Proceedings. 8: 79-85.

Brahmi, P., Saxena S. and Dhillon, B.S. (2004). The protection of plant varieties and farmers rights act of India. Current Science. 86(3): 392-398.

DAC and FW (2016). State of Indian Agriculture (2015-16). Department of Agriculture, Cooperation and Farmers Welfare, Directorate of Economics and Statistics, Ministry of Agriculture and Farmers Welfare, New Delhi: Govt. of India. pp. 280.

FICCI (2020). Industry's Voice for Policy Change, Decoding agriculture in India amid COVID-19 crisis.http://ficci.in/spdocument/23267/FICCI-GTReport-on-Agriculture.pdf

Foley, J.A., Ramankutty, N., Brauman, K.A., Cassidy, E.S. and Gerber, J.S. (2011). Solutions for a cultivated planet Nature. 478: 337-342.

Gadwal, V.R. (2003). The Indian seed industry: Its history, current status and future. Current Science. 84(3): 399-406.

Global Seed Market - Growth, Trends and Forecast (2019-2024), 2018, Mordor intelligence.

Godfray, H.C.J., Beddington, J.R., Crute, I.R., Haddad, L., Lawrence, D., Muir, J.F., Pretty, J., Robinson, S., Thomas,S.M. and Toulmin, C. (2010). Food security: the challenge of feeding 9 billion people. Science. 327(5967): 812-818.

Gopakumar, K.M. and Saxena, S. (2005). Seeds Bill 2004: For Whom?. Journal of the Indian Law Institute. 47(4): 483-501.

Green, R.E., Cornell, S.J., Scharlemann, J.P.W. and Balmford, A. (2005). Farming and the fate of wild nature. Science. 307(5709): 550-555.

Kaundinya, R., (2019). The Seed Bill Needs to be Tweaked to Serve the Interests of All Stakeholders Better, The Hindu Business Line, November 27th 2019.

Kumar, B. S. S., Agri War Room set up to assist farmers in Karnataka, The Hindu Newspaper, March 31st 2020.

Kumar, P., Singh, S.S., Pandey, A.K., Singh, R.K., Srivastava, P.K., Kumar, M., Dubey, S.K., Sah, U., Nandan, R., Singh, S.K., Agrawal, P., Kushwaha, A., Rani, M., Biswas, J.K. and Drews, M. (2021). Multi-level impacts of the COVID-19 lockdown on agricultural systems in India: The case of Uttar Pradesh. Agricultural Systems. 187: 103027.

Lohr, K., Camacho, A. and Vernooy, R. (2015). Seed Systems-An Overview. In: Farmers Seed Systems: The Challenges of Linking Formal and Informal Seed Systems, Documentation of Expert Talks, June 2014, GIZ, Bonn, Germany, pp 3-6.

Matson, P.A. and Vitousek, P.M. (2006). Agricultural intensification: Will land spared from farming be land spared for nature?. Conservation Biology. 20(3): 709-710.

OECD (2020). Coronavirus: The World Economy at Risk.

Phalan, B., Balmford, A., Green, R.E. and Scharlemann, J.P.W. (2011). Minimising the harm to biodiversity of producing more food globally. Food Policy. 36, Supplement 1, 62-71. DOI:10.1016/j.foodpol.2010.11.008.

Ravishankar, A., Archak, S., Kochhar, S. and Gautam, P. L. (2000). Plant Variety Protection: Lessons from cross-country perspective. Policy Brief No. 11. National Centre for Agricultural Economics and Policy Research (ICAR), New Delhi.

Santhy, V., Kumari, P.V., Vishwanathan, A. and Deshmukh, R.K. (2001). Legislations for Seed Quality Regulation in India. ICAR:Central Institute of Cotton Research. Technical Bulletin. pp. 19.

Seeds Bill, The Hindu Newspaper, December 13th 2019.

Singh, I.S. (2020). Agriculture in the time of Covid-19. The Hindu Business Line.

Singh, J., Kumar, V. and Jatwa, T.K. (2019). A review: The Indian seed industry, its development, current status and future. International Journal of Chemical Studies. 7(3): 1571-1576.

Sperling, L. (2020). Seed security response during COVID-19: building on evidence and orienting to the future. Food Security. 12: 885-889.

Tilman, D., Balzer, C., Hill, J. and Befort, B.L. (2011). Global food demand and the sustainable intensification of agriculture. PNAS. 108(50): 20260-20264.

Vilas Tonapi, A., Elangovan, M., Rajendra Prasad, S., Udaya Bhaskar, K, and Umesh, R., (2014). Seed Regulation. Directorate of Seed Research, Mau, Uttar Pradesh, India. ISBN- 978-81-925128-2-5.

World Bank (2019). Employment in agriculture (% of total employment) (modeled ILO estimate).