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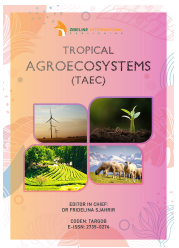

RESEARCH ARTICLE

QUALITY SEEDS FOR FOOD SECURITY AND FOOD SELF -SUFFICIENCY DURING HAVOC OF COVID-19 IN NEPAL

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ABSTRACT

Seed is the basic vital unit in agriculture, which is also basis for food security, conservation of biodiversity. It is also a means for the delivery of new technologies and support services to rural areas. Seed system is one of the most vital components of agricultural system that serves as an important element in strategies for agricultural development and poverty reduction. COVID-19 pandemic has affected almost every system worldwide. Seed system is not devoid of its effects too. Seed supply chain has been disrupted badly with very minimal workers around this sector, right now. Not only this sector but that of food safety, World Food security, has been affected severely as well. Importance of quality seeds is being understood, and is also being seen as basic tool for a secure food supply because of this havoc going around in the world. Quality seeds ensures good crop stand because of its high genetic and physiological qualities. So, with the institutional and technological enhancements in seed sectors, quality seeds can be used as solution for food security with addition to food self-sufficiency too. Production of seeds by following proper seed cycle, unifying seed system with complete knowledge and technological training on post-harvest operations up to marketing, utilization of maximum seed policies, seed schemes national, international both needs to be done in order to be self-reliable, sustainable, standard in line with sustaining food security and enhancing productivity.

KEYWORDS

Seed, agriculture, development, seed supply, food security, seed security, quality seed

1. INTRODUCTION

In broad sense, seed is a material which is used for planting or regeneration purpose. However scientifically, Seed is a fertilized matured ovule together covered with seed coat is called seed or it is a propagating material i.e., part of agriculture, sericulture, silviculture and horticultural plants used for sowing or planting purpose. Thus, seed is the most vital and crucial input for crop production, one of the ways to increase the productivity without adding appreciably to the extent of land now under cultivation by planting quality seed. Seeds have always been the key ingredient in the establishment, expansion, diversification and improvement of crop production. Seed is one of the major inputs of agriculture and means for dissemination of new technologies to farmers. They are the principal means by which plant populations have been and are distributed over both time and space.

Compared to the vegetative propagules used for some crops, seed are smaller, hence very convenient to store and transport, hardier and longer lived, easier to sow, relatively free of diseases, and a much smaller portion of the production is required for propagation. While seeds are marvelously adapted for propagation of plants, they have another function or role which is even more pivotal in crop improvement (Mózo, 2017). The COVID-19 pandemic, also known as the coronavirus pandemic, is an ongoing global pandemic of coronavirus disease 2019 (COVID-19), caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). The outbreak was first identified in Wuhan, China, in December 2019. The sudden outbreak of COVID-19 since first case being seen on 23 January, 2020 in Nepal, which became even more severe with the increase in number of cases, leading to the implementation of lockdown since 24th March, 2020 to slow down the spread.

Lockdown in Nepal came up with the restrictions in the movement of vehicles, neither within the districts nor outside any of the districts. The farm economy faced a severe hit when lockdown halted transportation, thereby stagnating the harvest. Even before this pandemic, Nepal had poor situation in agricultural sector. But because of the outbreak, growth in this sector seems to be lower than the fiscal year. Further, during the peak harvest, the produce could not reach markets, thus disrupting the supply chain. Also, the unavailability of migrant laborers, intercepting the harvest and post-harvest operations. The

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pandemic has given rise to several challenges in procurement operations as well. The agricultural sector is the highest employer in Nepal at 66% of the population, though this figure includes a very diverse array of quality of jobs that includes everything from subsistence to (small-scale) enterprise farming and wage-employment that is seasonal and part-time to permanent. COVID-19 is putting Nepal's small-scale producers and landless farmers under strain. Among those various sectors even within the agriculture, seed sector has been affected excessively too. Mainly, private seed organizations are on halt because of the urge of lockdown.

2. SEED SYSTEMS

UN has warned that the world stands on the brink of a food crisis worse than any seen for at least 50 years, so governments need to act swiftly to avoid disaster even for coming years. Scientists tell us that global pandemics like that of COVID-19 will be more frequent in coming years. So, in order to be prepared for such pandemics in future, the best way can be to enhance seed production. Seed is a fragile living entity and one of the most crucial elements in the livelihoods of agricultural communities. It is the repository of the genetic potential of crop species and their varieties resulting from the continuous improvement and selection over time. Within the seed technology, seed has to go through various stages for reaching from plants to farmers. To strengthen seed systems, we need to have a comprehensive understanding of them. Farmers, particularly small farmers, are involved in multiple kinds of seed systems, which help them produce and obtain the seed they need. These systems can be broadly divided into two types: a formal seed system and a local system. The local system is also sometimes called the "informal," "traditional," or "farmer" seed system.

The formal seed system is the easier to characterize, as it is a deliberately constructed system that involves a chain of activities leading to clear products: certified seed of verified varieties. The chain usually starts with plant breeding and selection, resulting in different types of varieties, including hybrids, and promotes materials leading to formal variety release and maintenance. Guiding principles in the formal system are to maintain varietal identity and purity and to produce seed of optimal physical, physiological and sanitary quality (FAO, 2020a). A local seed system is basically what the formal system is not. Activities tend to be integrated and locally organized, and the local system embraces most of the other ways in which farmers themselves produce, disseminate, and access seed: directly from their own harvest; through exchange and barter among friends, neighbors, and relatives; and through local grain markets (FAO, 2020a).

3. SEED SUPPLY CHAIN

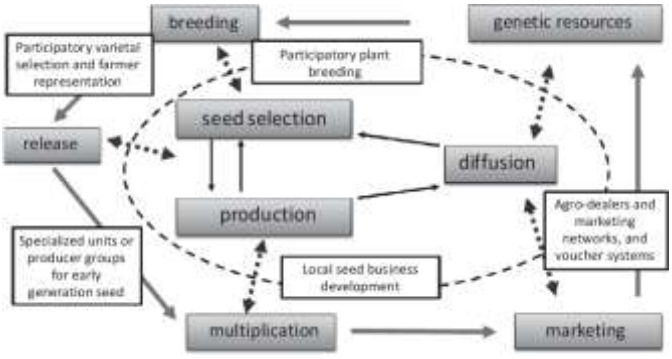

Figure 1: Integration between Formal and Informal Seed Systems in an Integrated Setting (Louwaars and De Boef et al., 2012)

The figure no. 1 shows the relationship between informal and formal seed systems in order to supply the seeds up to farmers. While the processing for the seed production, same general steps or processes take place in the local system as in the formal sector i.e., variety choice, variety testing, introduction, seed multiplication, selection, dissemination and storage. But the one in informal system takes place as integral parts of farmers' production systems rather than as discrete activities (FAO, 2020a). The steps do not flow in a linear sequence and they are not monitored or controlled by government policies and regulations.

Rather, they are guided by local technical knowledge and standards and by local social structures and norms (FAO, 2020a). Informal system includes community-based initiatives that include (i) Community Based Seed Production (CBSP), Small Seed Enterprises (SSEs), (ii) Community Seed Banks (CSBs); while groups organized under District Seed Self-Sufficiency Programme (DISSPRO) of the government of Nepal as semi-formal system, and Seed production and marketing through public sector, government owned national seed company and private sector as formal system (FAO, 2017b).

4. KEY PLAYERS/ ACTORS

Understanding of seed system structure and actors is essential to provide information about complexity of current seed system structure and role of different actors and sectors in delivering different class of seeds in seed value chain (Gauchan, 2015). Nepal's national seed system involves four different types of players: Public institutions, the private sector, international collaborators and farmer communities (Wyss et al., 2018).

Public Institutions: MoAD, NARC, NSC, NSB, DoA, DADO, SQCC, UAF, Genebank

Private Sector: SEAN, Seed companies, Agrovets, Seed importers, FNCCI
International Collaborators: CGIAR, donors, NGO's, Multinationals

Farmer Communities: Farmer groups, CBSP's, cooperatives, Social Activists

Note:
MOAD = Ministry of Agriculture Development; NARC = Nepal Agricultural Research Council; NSC = National Seed Company; NSB = National Seed Board; DOA = Department of Agriculture; DADO = District Agriculture Development Office; SQCC = Seed Quality Control Centre; UAF = University of Agriculture and Forestry; SEAN = Seed Entrepreneurs' Association of Nepal; FNCCI = Federation of Nepal Chamber of Commerce and Industry; CGIAR = Consultative Group on International Agricultural Research; INGO = International NGO; CSB = Community Seed Bank

The presence and weight of each actor varies considerably across crops and territories. In districts of the Terai (plain region) such as Bara and Chitwan, and for crops like rice, wheat and maize, the involvement of actors from the public sector and seed enterprises is greater than in mountainous areas. Seed services facilitated by the District Agricultural Development Offices (DADO's) are present in most districts, but in some of them, these services do not reach remote villages (Wyss et al., 2018).

5. PROBLEMS ON SEED SECTOR DUE TO CORONA/ COVID-19

Because of the prevalence of corona all over world, not leaving Nepal, has led to closing up of every system. Neither governmental nor private sectors were on run during complete lockdown. With minimal facilities of movement of food, the operations on seed sector was almost equals to null. As shown in figure no.1 of supply chain and numbers of key players mentioned above for seed production presents that producing seed and it's accessibility to farmers in each and every nook of the country is not a one day job. Obviously, based on the life-cycle of each crops, the stage up to production of seed within plants is a long-process; but in addition to that various post-harvest operations including to storage takes multiple steps. Implications of no-transportation has resulted in return of workers to their hometown, causing less number of workers ranging from field workers to technicians in seed production.

This has undertaken almost no production of seeds from private sectors. Also the import of seeds from international donors has not been possible due to restrictions on international flight. And the options that we are left with, during such scenario is the use of source seeds produced by farmers in neighborhoods without any authentic knowledge on seeds' quality; as in current situation, our country is not proficient enough to provide with

adequate choices of preferred varieties, hybrid seeds to the diverse group of clients in different agro-ecological domains, socio-economic settings. Piling up of quality seeds by immature seed companies for immoral activities has also been seen to cause unregulated seed distribution without following seed policy of Nepal, distorting production ability of potential sectors, regions.

Due to the lack of logistic support and technical manpower in NARC, there is no consistency in the production of Breeder Seeds. The obstruction of vehicles results in inadequate market support causing weak input relationships. And one of the main problem to be considered during this scarcity is volatile market, where the price fluctuation was common during the beginning of COVID-19 cases in Nepal. The aforementioned cases are some of the direct and short-term problems caused due to this pandemic. But there is one, the major and long run problem arose due to this pandemic. And it's the problem of food insecurity and food in-self-sufficiency. In Nepal, the vision of growth in agricultural sector was supposed to be about 2%. But now, it seems to be hindered and fallen by even more range than the fiscal years'.

5.1 Food Security and Food Self-sufficiency

Food security has been defined in many ways, but one of the more widely accepted definitions is the one provided by the 1996 World Food Summit: *"Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life".*

This widely accepted definition points to the following dimensions of food security:

Food availability: Sufficient quantities of food of appropriate quality should be available to all people, particularly to the poor, supplied through domestic production or imports (including food aid)

Food access: It also emphasizes the fact that food security is a dynamic concept in that access by individuals to adequate resources (entitlements) for acquiring appropriate foods for a nutritious diet must be stable over time.

Entitlements are defined as the set of all commodity bundles over which a person can establish command given the legal, political, economic and social arrangements of the community in which they live (including traditional rights such as access to common resources).

Utilization: Utilization of food through adequate diet, clean water, sanitation and health care to reach a state of nutritional well-being where all physiological needs are met. This brings out the importance of non-food inputs in food security.

Stability: To be food secure, a population, household or individual must have access to adequate food at all times. They should not risk losing access to food as a consequence of sudden shocks (e.g. an economic or climatic crisis) or cyclical events (e.g. seasonal food insecurity). The concept of stability can therefore refer to both the availability and access dimensions of food security (Source: FAO, 2006; IFPRI, 2010).

In order to say, three aspects, i.e. physical and economic availability and food safety and quality, as well as the stability of all these dimensions over times, are addressed in the most commonly used definition of Food security (Baer-Nawrocka, 2019). In the literature, food security is usually considered at three levels: the farm level, the national level and the international level. All of these dimensions are interconnected, and therefore form a set of targets which are often difficult to extract (Baer-Nawrocka, 2019). As emphasized by Srinivasan and Dawe, in addition to price and disposable income, food security at household (Farm) level is also largely affected by: the rural population's level of and access to education (especially as regards women and poor); child healthcare; food education; consultancy on how to manage farms and set up kitchen gardens.

At national level, food security is generally assessed based on actual average energy intake per capita in relation to the needs which are determined in accordance with minimum recommended nutrition standards. The selection of a national food security strategy depends on production resources and on the systemic and institutional condition of the political, economic and social life of a country. In that context, there are three main types of agri-food policy solutions aimed at food security. There are three main types of agri-food policy solutions aimed at food security: *food self-reliance, food self-sufficiency and food sovereignty* (Baer-Nawrocka, 2019). While the assumption of the first strategy, i.e. food self-reliance is to produce and export goods in which the country has a comparative advantage (which provides many opportunities, including the generation of financial resources and imports of other agricultural products), the two other, i.e. food self-sufficiency and food sovereignty are based on enhancing the domestic production of basic agricultural products, though the country has no comparative advantage in it.

The strategy based on food self-sufficiency (which limits the role of imports to food products) became increasingly important during the last economic crisis. At that time, many countries found it to be one of key priorities for their agri-food policies (Baer-Nawrocka, 2019). Food self-sufficiency is part of the larger issue of food security. According to FAO, "*The concept of food self-sufficiency is generally taken to mean the extent to which a country can satisfy its food needs from its own domestic production"* (FAO, 1998).

In contrast, this definition highlights to the ability of a country, region, or household to meet its food needs from its own production. Usually, food self-sufficiency is defined in terms of the staple food crops, such as basic cereals and root crops. A more practical application of the concept of food self-sufficiency is defined as a country producing a proportion of its own food needs that approaches or exceeds 100 percent of its food consumption.

This definition does not exclude trade as a possibility, and instead expresses food self-sufficiency as a percentage, or ratio of consumption (FAO, 2015-16). The assumption that food security and seed security are closely linked, and that an insecurity in one sphere unambiguously leads to insecurity in the other, on the surface seems logical. Seed is an essential input for agriculture, so seed insecurity undermines subsequent production. Further, many poor farmers obtain most of their seed from local production or local market channels, so food insecurity arising from poor harvests or market failures could also make seed unavailable. To put it another way, closely linking seed and food insecurity assumes that a given factor – for example, drought, or price spikes in local markets – will affect both spheres in very similar ways (McGuire, 2011).

Seed security*: 'Farming households (men and women) [having] access to adequate quantities of quality seeds and plant materials of adapted varieties at all times – good and bad'* (FAO, 1998).

According to a study, though similar, these parameters have subtly different meanings for food and seed security (McGuire and Sperling, 2011):

- **Availability**, the physical presence of food/seed in the area from any source or of any quality, is a constant concern for food, so its temporal aspect is not specified, but availability of seed is critical for defined periods around planting time.
- **Entitlements** (via production, markets, barter, gifts) shape access to both food and seed, although this may come through different means, involving different actors.
- **Utilization** has two aspects for both food and seed security: (a) physical quality – suitability for use as food or seed (i.e. can it be eaten, or will it germinate?); and (b) more innate quality with respect to specific users – does the food/seed have the right characteristics to meet their preferences and needs (for example, food that is digestible and nutritious for specific groups such as children or the ill; crop varieties with traits that users want, which can perform in their local environments).

So, if food self-sufficiency is one of the biggest contributor to food security, and there is direct relation between food security and seed security. Hence, we can confidently tell that for food security and food self-sufficiency, seed security in addition to seed self-sufficiency is also required.

5.2 Food Insecurity during COVID-19 in Nepal

India is one of the biggest contributor of food goods in Nepal. The shortage in the supply of vegetables from India, rice exports were also halted from India, affecting food availability dimension of food security (WFP, 2020a). During the on-going of lockdown, the harvesting of Wheat all over Nepal was only completed by 30-40% at around 13th April and at the report of beginning of May it was completed by 80-90%, but the main problem here came by the restriction on supply of those harvested wheat due to no transportation (WFP, 2020a&b). 85 percent of traders reported that the supply of goods decreased, with 90 percent of traders reporting a decrease in transporting trucks and other vehicles (WFP, 2020b). While maize sowing is going on in Nepal, reports of Fall Army Worm infestation in newly germinated maize crop in some of the districts, has created fear on farmers (WFP, 2020b). Localized hailstorms and strong wind have affected winter crops, vegetables and fruits in some parts of Provinces-1, 2, Bagmati, Gandaki, Karnali and Sudurpaschim (WFP, 2020b).

5.3 Seed Insecurity during COVID-19

With the inter-linkage of food security and seed security, the insecurities under food sector also includes seed insecurity. As there are limitations with the availability of seeds and other inputs during jammed market everywhere over Nepal, the few seeds that are available with farmers were used as respective to growing seasons. But the consequences of unprecedented climatic hazards and insect-pest manifestation not only has caused loss of seeds but also the wastage of inputs. Vegetables are the greater contributor in economy of Nepal compared to cereal crops. As it can also be grown under small spaces within house compared to that of cereals; even in food-grain dominated areas most of favorable vegetables can be grown as under various inter-cropping patterns. But limited availability of vegetables and low availability of vegetables seeds, have neither benefitted seed sector. The framework for seed supply chain in Nepal has completely broken off during this period. That's why, one of the popularly viewed solutions for solving food insecurity during this pandemic of COVID-19 is: *Availability of Quality Seeds.*

5.4 Quality Seeds

Seed is one of the most crucial elements in the livelihoods of agricultural communities. It is the repository of the genetic potential of crop species and their varieties resulting from the continuous improvement and selection over time. The potential benefits of seed to crop productivity and food security can be enormous (FAO, 2020a). Every farmer should able to access healthy seeds which are genetically pure, with high seed vigor and good germination percentage. Timely availability of good quality seeds at reasonable price ensures good yield and profit to the farmers. The seeds plays a vital role in agriculture and acts as a carrier of the genetic potential of varieties (Parimala et al., 2013).

Quality seed can be defined as varietally pure with a high germination percentage, free from diseases and disease organisms, with a proper moisture content and weight. Quality seed production which follows efficient certification procedures plays a major role in the increase of food production of our country. The quality of seeds and young plants is important to end up with a good crop and with it good and plentiful availability of the products. Maximum profits can be reached by combining good seeds with the right cultivation methods. Good seeds and young plants also contribute to the efficient use of resources by local farmers, promote job opportunities, lead to safer and healthier food, and dealing with effects of climate change. It ensures good germination, rapid emergence, and vigorous growth. These aspects translate to a good stand (whether greenhouse or field).

5.5 Characteristics of Quality Seed

5.5.1 Seed Health

Seeds should be devoid of insect damage and infestation by any microbes like bacteria and fungi. It refers to the diseases specified for the seed certification which may cause contamination of seed lot.

Ex; loose smut of wheat (*Ustilago tritici*)
Kernal smut of sorghum (*Sphacelotheca sorghi*)
Grain smut of pearl millet (*Tolyposporium penicillariae*)
Ergot of bajra (*Claviceps microcephala*)
Early blight of tomato (*Alternaria solani*)
Little leaf of brinjal (Datura virus-2) etc.,

5.5.2 Physiological Attributes

Seeds with good germination capacity and seed vigor are considered as quality seeds.

5.5.3 Seed Germination

Germination capacity of a seed lot refers to the capacity of the seeds in that lot to germinate normally and produce all parts of a healthy seedling and grow. A germination rate of 70-80% is an indication of high seed viability.

5.5.4 Seed Vigor

Seed vigor is the sum total of all the seed attributes that favors rapid and uniform standard establishment in the field under varying field conditions. In general, seeds with good germination capacity and uniformity in size will have good vigor. Seeds with good vigor will produce good quality seedlings that will grow and give good yields.

5.5.5 Physical Purity

The physical purity of the seeds should be maintained at 96-98% and the seeds should be of uniform size and shape without any damage.
Example: All crops: 98%
Carrot: 95%
Ragi: 97%

The seeds should be devoid of inert matter like dust, stones, seeds of other crop varieties, broken seeds, weed seeds, etc. After harvest, seeds should be separated from chaffy seeds and insect or disease affected seeds in order to maintain the physical purity of the seeds.

Free form other crop seeds (number/kg): designated inseparable crop seeds are the plants seeds cultivated crops found in the seed fields and whose seeds are so similar to crop seed that is difficult to separate them economically by mechanical means, cause physical admixtures with the crop seeds only when these crop mature approximately at the same time when seed crop matures. Ex. In barley: oats and wheat seeds.

Free from objectionable weed seeds: these are seeds of weed species which are harmful in one or more of the following ways:

- The size and shape of weed seeds are similar to the crop seed and difficult to separate them by mechanical means causing unhealthy competition with the crops for all inputs.
- Weed plant parts are poisonous or injurious to human and animals i.e. obnoxious type.
- Weed plants also serves as alternative hosts for pests and diseases.

Ex. Bersem: chicory
Paddy: wild paddy (Oryza sativa var. fatua)
Cucurbits: Wild cucurbits spp.
Lettuce: Wild lettuce
Hendi: Wild *Abelmoscous* spp
Wheat: *Convolvulus arvensis* (Hirankuri)

5.5.6 Genetic Purity

Genetic purity of the seed should be maintained in order to ensure the quality of the seeds. The traditional and inherent characteristics of the seed should be maintained from generation to generation and is referred as genetic purity. The characteristics of the progeny should exactly resemble its mother plant. Seed should adapt to local conditions with high yielding capacity.

Breeder/nucleus: 100 %
Foundation seeds: 99.5%
Certified seeds varieties: 98%

5.5.7 Moisture Content of Seeds

Seeds with high moisture content will loose its germination vigour and viability soon. Hence, it is necessary to maintain correct moisture content of the seeds in order to ensure the good germination capacity and viability. It is also essential to protect the seeds from pest infestation and attack by diseases. Seeds should be stored at a safe moisture level of 9 – 13%. Moisture content of the seeds is measured directly using digital moisture meter.

Cereals: 10-12 %
Wheat, Barley: 8-10%
Pulses: 7-9%
Oilseeds: 6-7%
Soybean: 8-10%
Vegetables: 5-6%

Apart from optimum moisture content of seeds, other factors like temperature should also be considered. Seeds should be stored at low temperature. Also the provision of seed treatment like fungicides, insecticides and occasionally, antibiotics can be done while storing to prevent from insect-pest and diseases.

5.6 Quality Seeds as a Solution to Food Security and Food Self-sufficiency

With the observation of aforementioned qualities of quality seeds, we can come to certain understanding how much is quality of seeds important for better crop stand and high input efficiency. Producing quality seeds is an effective tool to address the issues of self-sufficiency, food security and economic development. For the assessment of quality seeds, main things that matter are purity, germination and moisture content of seed lot. For that, certified seeds are highly used, which have really purity. Certified seeds are of mainly four types: Nucleus seed, Breeder's seed, Foundation Seed (I and II) and Certified Seed (I and II). If such seeds are available to the farmers, then it can be advantageous for them in many perspectives like uniform plant population and maturity.

As they are also found to be profitable in terms of monetary as farmers can get high return per unit area as the genetic potentiality of the crop be fully exploited, with the increased nutrient-use efficiency. It can be a sound material for transforming the agriculture of Nepal, mainly in rural sides, as it supports on the saving of money of poor farmers, and high production and supply in market from rural sides supporting GDP of country.

5.7 Advancement in Plant Breeding to cope with possible future threats

While humans were struggling with pandemic of corona virus, locust plague has also triggered a catastrophic alarm. Billions of locusts which began in East Africa, have crossed the red sea into Europe and Asia, reaching Pakistan, Iran which later on spread in India on May 26, 2020 where about 400 billion locusts have attacked India's Rajasthan State, destroying crops and threatening to spread to other states. The United Nations Food and Agriculture (FAO) said extreme weather caused by global climate change was the major factor for the emergence of the locust plague. And they have migrated in South Asian region in search of food and favorable hot temperature which is increasing as summer in this region.

The travel of locust to India have mainly damaged the crops and it's the threat to Nepal on coming days as locusts are traveling in search of food. As COVID-19 is climbing peak in increased cases in Nepal which has already impacted huge loss for agricultural sector and now the entrance of locust will worsen the situation more, mainly by the loss of crops. Because of this grain safety, supply chains are under threat. In order to prevent it, breakthroughs in institutional innovation under grain safety and seed production should be stepped up, helping grain enterprises more to be powerful and become the significant carrier of national grain security.

5.8 Proper Qualities for Use by Everyone

While going through the basic characteristics for the quality seed production, we have been through genetic make-up of progeny, which is also an important factor. One of the basic thing to be considered while producing quality seed is that, it should have right organoleptic characteristics, which means compatible traits as per preference of locals i.e. for processing, cooking, color and even taste characteristics also. There have been various cases reported in the past where farmers have rejected on the use of some newly introduced varieties because of their poor taste or cooking and processing nature, as per complaints reported by consumers too. So, quality seeds not only ensure on its ability to tackle some adverse natural conditions only, but also focuses on the preferences of consumers for their diet with high nutritional value. This supports on the fact that seeds coming via formal system is trustable as it comes down to market after complete inspection from field to lab, so it can prevent on the reduction of food insecurity that is resulted due to production of some un-preferred varieties by checking on them.

Seed dormancy is the temporary suspension of growth of viable seeds accompanied by reduced internal metabolic activity. It is the resting stage of the seed and it delays germination of the seed. Seed dormancy is the survival mechanism of seed during unfavorable environment condition because of which it can be saved even during hazards. But if the seeds are low in quality even at the pre-dormant stage, then after post-dormancy their qualities will go down by greater range based on dormancy period. But if we use quality seeds for crop production, seeds produced from them will have high quality even at pre-dormant stage Then even after facing dormancy period, although their qualities may get reduced by some extent, but measurably it will be high compared to that of not-so-good seeds, enough to produce good stand for subsistence feeding to their families even for 1-2 times during crisis like Corona.

5.9 Solutions for Seed Sector arose Due to Corona

Production of quality seed and for making it reach it out to every farmers in every part of Nepal efficiently, it needs to be supported by many institutions and government too. As there are many projects going on in Nepal for agriculture like Food Security and Agricultural Project Analysis Service (ESAP), so going on for "New Normal" can be even easier with collaboration with such projects. There are companies like National Seed Company Limited (NSCL), Nepal Agricultural Research Council (NARC), etc. Ministry of Agricultural Development has developed a National Seed Vision 2013-2025, co-operation of such companies, formulations of even more policies, and even more innovations and investments is one of the most reliable part supporting for sustainable seed sector even after this pandemic.

5.9.1 Actions from Actors of Seed system

As we already know, seed production goes through processes like breeding, testing, seed production, processing, sales and extension services where various actors have their own roles.

- Variety development, maintenance and breeder seed production and supply are mainly carried out by public research institutions.
- Foundation seed is produced and multiplied by both public research institutions and private sector including Community Based Seed Producers (CBSP) groups in close supervision of NARC research centers and some NGOs (LI-BIRD, FORWARD).
- Commercial seeds (Certified, Truthful labeled and Improved) are mainly multiplied and marketed by private seed companies, co-operatives and CBSP groups.
- The marketing functions are the main domains of private seed dealers Agrovets and Seed traders (Gauchan, 2015).
- The public sector dominates in seed multiplication of cereal crops mainly by NSCL, whereas private seed companies play an important role in vegetable seed multiplication.

During pre-corona period, major issues identified in seed sector are low investment in plant breeding, poor seed processing and quality management procedures, lack of promotion and advertising campaigns

and weak extension programs. So one of the best possible solutions for seed sector post-corona can be enough subsidies, investments for research over plant breeding, seed production sectors and seed trade, with more trained manpower recruitment for field work to lab as technicians, with supportable and trustable marketing teams. Small seed enterprises, CBSPs and CSBs can work more vividly on decentralization of seed production and provisioning.

5.9.2 Following of National legislation on Seed Sector by Informal system

Several seed policy instruments were formulated in last two and half decades. But formulating legislations and policies is one thing, the more important aspect is how effectively they were implemented and whether or not the policy instruments produced intended results/changes in a given situation and timeframe. Lack of political stability, weak law and order situations, prevailing socioeconomic conditions, population dynamics and external factors are the mainly cause of failure in case of Nepal. Most of the seed policies and regulations prepared and implemented so far largely consider the formal seed systems (except in case of landraces and indigenous knowledge) that operate with a few released and registered crop varieties. Informal seed systems in Nepal probably enjoy most flexibility as farmers do not have to comply with any seed regulations. In Nepal, due to the dominance of informal seed system, demand for crop variety depends on how widely any crop variety is known and used already. Any such demand is created due to the popularity rather than agronomic performance and genetic merit of the varieties.

Such a system favors production of outclassed varieties unless a systematic advertisement campaign for new varieties is in place. New varieties are less demanded because farmers are not aware about the better available options as the availability of private, public sectors supporting formal system are limited in numbers, and not enough to cover rural areas. This shows that even the regulations of policies and rules are not always enough to run a productive system in country unless those rules are not implied by governments strongly. There are many examples of developed countries country like Canada, where some restrictions among the formulated ones are followed by FSS or ISS. So, after the opening and loosening up of lockdown after corona, this sector can be improved by Government.

As this gives opportunity for informal and formal sectors to work hand-on-hand for providing seeds as per demand to the farmers. Informal seed system will benefits from a dynamic formal seed system that is fully linked with modern advances in plant breeding. New recovery model can also be created for the informal system from the legislative under seed sector to make availability of seeds on reliable sides for everyone. Similarly, formal seed system will benefit from the informal system in many ways and most importantly in terms of acquiring precious landraces and indigenous knowledge associated with the traditional varieties for using in pre-breeding research. Strong and live interactions, learning and sharing between the two systems for continuously internalizing good practices will make overall seed system more dynamic and responsive to the needs of the farmers and country as whole.

5.9.3 Encouraging Farmers for Seed Replacement

The quality seeds of popular high yielding or hybrid varieties are the good seeds preferable to the farmers for cultivation. The productivity in agriculture will increase by many-folds if bad seeds are replaced by good and quality seeds. The farmers will be very encouraged and benefitted by replacement of the bad seeds by the good ones (Hasanuzzaman et al., 2015). Since the quality of farmer's saved seeds is poor, the availability of quality seeds will not only improve seed replacement rate but also help saving of seeds by using lower dose of seed per unit area (Hasanuzzaman et al., 2015).

5.9.4 Digitalization on Seed Sector

As we went through the problems in seed sector in this pandemic, seed assessment was found to be one of the greatest problem. So, extension system should be flourished now, after post-covid situation. At present, Seed Quality Control Center (SQCC), Nepal Agriculture Research Council (NARC), the Centre for Crop Development and Agro Bio-diversity Conservation (CCDABC) and the Vegetable Development Directorate (VDD) are using paper-based data collection systems to record and plan seed production every year. Introduction of digital system for certification, assessment on information of new seeds, hybrid seeds, new rules and laws on restrictions, management can help in continuation of supply chain even in future disasters to occur where if transportation will be put in halt. It increases traceability including even in supply chain. Now-a-days, people have access to mobile phone, even at rural areas, so it will be an effective tool to access digital system at most of the areas.

The best thing about it is that, it can be a good tool to combat fraud in extension system. It can also be a time efficient tool. Digital solutions are critical to link the agricultural market with vital information so farmers can make decisions for better production and harvest. Another advantage provided by digital system in the context of Nepal is, till the date there has been introduction of such apps that gives information about the crop types based on regions, climatic factors to the farmers (Dawe, 2002). By enhancing that characteristics, more of seed regulated type of apps can be created that collects feedbacks from farmers on their preferred varieties of different crops, and also can function to provide information on newly introduced varieties seeds in the market. It can liven up e-commerce platform among retailers.

5.9.5 Launching of SeedNL in Nepal

On the 16th of October, international World Food Day, SeedNL was launched. SeedNL is a public-private partnership with as its goal to strengthen the seeding industry in developing countries to improve the productivity of local growers. The partnership consists of the Ministry of Agriculture, Nature and Food Quality, the Ministry of Foreign Affairs, and Plantum, the trade association for companies working with seeds and young plants. The projects of SeedNL aim at training the growers to grow better crops and to generate more income with them. The projects pay special attention to the availability of good seeds (FAO, 2019). To realize this, good and practical rules are being made to follow if wanted. By working on the availability, access, and the use of good quality food crop seeds, SeedNL aims to contribute to the accessibility of safe, nutritious and plentiful food, countering malnutrition and raising the sustainability of food production (FAO, 2017b). Since it's a new scheme established in the seed world, so by associating with SeedNL, various new projects under seed improvement with other international partners can also help in uplifting of seed sectors.

5.9.6 Increase in association with international companies

Eighteen index companies report having a presence in Nepal. While six companies indicate having testing locations in the country. Advanta and Lal Teer seed are the only two companies producing seed. And, Lal Teer Seed is the only company that has a full seed value chain in Nepal from breeding to extension services. At the current situation, processing plants and dedicated extension services are the major areas of improvement for companies (Srinivasan, 2000).

Leading this discussion, Nepal can work on increasing association with those international companies that work in especially those two sectors, with high ranks in seed indices among seed companies like Advanta, Acsen Hy Veg, etc. By taking inspiration from Africa; a country that has been facing many crisis since decades and decades where breakout of HIV/AIDS, Ebola, locusts plague had taken place and had led to them for food insecurity for innumerable times, as they are one of the exemplary and prominent country to work for sustainable agriculture and have achieved it by great extents too. Africa also has lots of public seed companies that ranks pretty high in seed indices too. So by enhancing the existing seed companies like Annapurna, Lumbini, NSC, NSCL, Unique seed and we can open even more of such companies for being self-reliant in producing seeds ranging from breeding to extension services.

5.9.7 Enhancing the Genetic Factors of Seeds through Breeding

The most initial part during seed production is the breeding part. So, to enhance the genetic make-up of the seeds, we need to take care of the part of pollination. According to the ITPGFRA, acknowledging that the conservation, exploration, collection, characterization, evaluation and documentation of plant genetic resources for food and agriculture are essential in meeting the goals of the Rome Declaration on World Food Security and the World Food Summit Plan of Action and for sustainable agricultural development for this and future generations. The Treaty's truly innovative solution to access and benefit-sharing is its declaration that 64 of our most important crops - crops that together account for 80 percent of all human consumption - will comprise a pool of genetic resources that are accessible to everyone.

By implementing multi-lateral treaty by ITPGFRA, breeders of various scientific institutions and private sector gets the opportunity to work with potentially and improved materials stored in gene banks of regional, national and international level of various countries gives exposure to wide range of genetic diversity to seeds. Also by facilitating research, innovation and exchange of information without restrictions, this cuts down on the costly and time consuming need for breeders to negotiate contracts with individual gene banks. Through which, desired inoculation of required traits can be done, and even more experimentation can be done to produce more advanced seeds. This can also promote on more use of farmer's right to save, use, exchange and sell farm-saved seed and other propagating material, and to participate in decision-making regarding, and in the fair and equitable sharing of the benefits arising from, the use of plant genetic resources for food and agriculture.

It is vital to use indigenous plant genetic resources for food and agriculture through pre-breeding process to develop climate resilient crop varieties with high yield and better agronomic performance. Coordination between all the institutions for PGR exchange needs to be in place to regulate the exchange of plant genetic resources for food and agriculture in the best interest of the country. Popularising and institutionalising 'truthfully labelled' seeds as flexible means of promoting seed trade in the rural areas by informal, semi-formal systems and formal systems can directly contribute to strengthening food and nutritional security as well as create additional business opportunities in seed industry.

5.9.8 Providing Seeds on Kitbox as Relief Package

As the lockdown as going in countries, many times news about relief packages were hitting too. More refined form of this system as a new act in Seed sector can be continued as "New Normal" by initiating this thought with a kitbox which not only includes foods, clothes and other things but also includes seed packages of main cereal crops and vegetable crops. Even, this thought can be initiated as a part of effective promotion of recently introduced varieties in Nepal. Provision of supplying seeds in packages within a certain group by acting them as a significant unit. So, farmers can investigate on those varieties as per their favorability and preferences in many terms, with low monetary act and reduced risk even if it doesn't go good. In another side it acts as a benefit for seed producing and seed importing units for intensifying the popularity of newly adopted varieties among rural farmers. Moreover, continuous inspection on those farmers can be done to know about the behavior of given varieties in long term uses; so that if any dysfunction found in it, it can be helpful for further biotechnological improvement on them to secure food for future generations.

5.9.9 Increased Seed Storing Facilities

For successful and systemized production of quality seeds and for prolonged flow of it in seed-chain, one of the most important factor for it is seed storage units in Nepal. Building and repairment of seed storage units in new areas can be the new area of focus within seed sector as post-corona situation. For storing seeds, many things need to be considered like temperature regulation to maintain moisture content of seeds, to maintain viability of seeds; provision of protection from insects and mites, to successfully operate seeds' qualities. As we have already gone through the information that most of the seeds in value chain comes from farmers' seed system.

High temperatures and humid conditions combine to cause rapid deterioration of seeds in open storage, resulting in lost value, poor stand establishment, lowered productivity and a disincentive to invest in improved seeds. Most horticultural seeds in Nepal are locally produced or self-saved and stored without facilities for maintaining dryness that would greatly extend the seed longevity in storage. So more focus should be done for preparing storage units from farmers' preferences and requirements, with the inclusive concept of agro-climatic conditions of farmers'. Hermetic storage with plastic sealing, rustic storage (for potato) etc. are some of the popular choices as storage bags. More of such bags that are eco-friendly is an opportunistic area for exploration and improvement within seed sectors.

5.9.10 Introduction of Sanitary measures in Agriculture

During the havoc of COVID-19, area of hygiene gained the most attention among all people, of all societies. Among many bad 'Old practices' that is being followed in agriculture, one of them is working under unhealthy and dusty operating environments of agriculture. Although it hasn't hit attention of many people but it is also a sector within agriculture that needed to be advocated. And it's all thanks to this pandemic, farmers are now getting more aware of their health. So, agricultural laws now should be inclusive about the sanitary habits among farmers, technicians, labors. As of now, provision of good masks, with sanitizers, access to clean water along with other necessities as per their suitable requirements should be given to them. Phytosanitary measures were always an attentive sector among seed exporters. But now, strong quarantine checkpoints need to be established in the border sides with technical knowledge in the given sector; to allow the access of healthy, safe seeds in country as per the vision of food safety.

5.9.11 Usage of micro-climatic condition in integration with workshops training

Nepal has a diverse range of agro-ecological conditions ranging from tropical to sub-tropical and temperate due to altitude gradient from the southern plain of the terai to the hills and mountains. Topography and geology provide a multitude of agro-ecological pockets, many with favorable soil and water conditions that are suited to a wide range of annual and perennial crops, as well as location specific livestock breeds. Nepal's source of comparative advantage lies to its unique natural resource base. Comparative advantage refers to a situation where a country has relatively favorable factor conditions which can serve as the basis for developing competitive advantage in the marketplace. Such factor inputs may include natural resources, human resources, capital resources, physical infrastructures, and information infrastructure. The agro-ecological diversity has always been advantage for running agricultural practices. This is the reason why, people in Nepal can quickly adopt and adapt with agricultural practices because of gift of natural resources that promotes for agricultural development. There are numbers of regions that can act as main hubs for supplying main crops to people all around Nepal. But also the presence of pocket areas, off-season production is also one of the popular sector that is fostering in agriculture. These sites can also be utilized as seed breeding hubs either on or off seasons. In addition to agricultural development as per agro-climatic conditions, workshops for training local people with necessary knowledge should also take place. This is another sector that can be fostered after the pandemic for agricultural seed sector development.

6. CONCLUSION

Now, it's not a matter of wonder that nature is deteriorating in rapidly with the increased population, urbanization, industrialization; that has disturbed balance within complex, causing many climatic hazards. But, mother-nature knows how to heal herself, so once in a while World has

been hit by such pandemics since centuries which if not controlled can even lead to human extinction. UN has declared that in future too, we will be hit by pandemics worst even than we are going through. That's why, unlike pre-corona situation, we need to stop thinking about only present moment but also focus for sustainable future. Preparedness plans within agriculture sector needs to be done by revolutionizing seed sectors. So, that people won't need to go through situation of food crisis, hunger, lack of cultivating source materials. Lives of "New Normal" or "Better Normal" need to be adopted by people for better and sustainable environment.

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