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Review

Knowledge management for plant biosecurity in South Asia

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Knowledge management promotes an integrated approach to identify, capture, evaluate, retrieve and share information assets for enhanced knowledge processing. Agriculture forms the backbone of rural livelihoods and national economy in South Asia. The food security which largely depends on plant biosecurity in South Asian countries is challenged by devastations in agricultural crops caused by diseases and pests and the problem is further aggravated by the dearth of resources devoted to their management. The geographical location, climatic suitability and the diverse agricultural scenario predisposes the South Asian region to new/emerging native pests and diseases many of which have a potential to establish and cause serious economic losses. The region, with its high population and increasing trade, thus requires a proper knowledge management in biosecurity encompassing available information and programmes on regulatory, technical and infrastructural parameters at one platform. The knowledge management in plant biosecurity will help in collating and harnessing information for timely and accurate diagnosis of the pest and will be an indispensable tool for developing and implementing an early warning system and a rapid response strategy in case epidemics break out. Also, it will contribute to collate and harness the information on pests and will facilitate capturing the market for export. The South Asia countries need to come on one platform to strategize collectively in this aspect to harness the natural and knowledge resources in the region to ensure an effective plant biosecurity in the region. For this, the countries/organizations need to align their strategies with the knowledge base of the country by keeping pace with technology and using regional bodies as a platform to achieve the objectives.

Key words: Knowledge management, food security, biosecurity.

INTRODUCTION

Knowledge is universally known as the fundamental basis of survival and competition from time immemorial. In organizational context, knowledge management is concept in which an enterprise gathers, organizes, shares, and analyzes its knowledge in terms of resources, documents and skills. It is the process through which organizations generate value from their intellectual and knowledge based assets. Organizational competitive advantages ultimately rest on its knowledge resources as it is difficult to copy. To successfully bring change through

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knowledge management practices, organizations need to align their strategies with the current knowledge base of the people and such initiatives need to be further reinforced by process changes keeping pace with technology.

Reflecting its mandate and competencies, the Food and Agriculture Organization of the United Nations (FAO) plays a leading role in normative work and technical assistance, at the both the national and international levels to support the implementation of a biosecurity approach (ftp://ftp.fao.org/docrep/fao/010/a1140e/a1140e01.pdf) and the member countries owing to the complexity of the parameters that needs to be considered to ensure biosecurity. Biosecurity is a strategic and integrated approach that encompasses a policy and regulatory framework to analyze and manage risks associated with food safety, plant and animal health and the environment. It covers the introduction of plant and animal pests and diseases, and zoonoses; the introduction and management of invasive alien species and genotypes; and the introduction and release of genetically modified organisms (GMOs) and their products (http://www.fao.org). Thus, biosecurity is a holistic approach to the sustainability of agriculture, food safety, and the protection of the environment, including biodiversity. It includes biosafety, a term used to describe policies and procedures adopted to ensure environmentally safe application of modern biotechnology including products derived from the use of recombinant DNA technology.

South Asia is the southern region of the Asian continent, which comprises the sub-Himalayan countries and, for some authorities, also includes the adjoining countries to the west and the east. According to the United Nations geographical region classification, Southern Asia comprises the countries of Afghanistan, Bangladesh, Bhutan, India, Iran, Maldives, Nepal, Pakistan, and Sri Lanka. South Asia is home to well over one fifth of the world's population, making it both the most populous and the most densely populated geographical region in the world. The South Asian Association for Regional Cooperation (SAARC) is an economic cooperation organization in the region.

Agriculture forms the backbone of rural livelihoods and national economy in South Asia. Rapid growth of agriculture to meet the food security has also created multitude of problems in the production systems. Any adversity in the form of a natural or deliberate outbreak of a pest or disease can inflict severe losses to the farming community and can jeopardize the national economy. The geographical location of South Asia and the diverse agricultural scenario predisposes it to alien as well as new/emerging native pests and diseases of crops. The mealy bug problem in cotton, viruses in legumes and horticultural crops, *Parthenium* menace have highlighted the bottlenecks in the security of farming systems.

Besides, the external threats through imports of agricultural commodities, bioterrorism and from rare emerging and new diseases of plants have also to be tackled for ensuring agricultural security (Khetarpal and Gupta, 2007). The liberalization of global trade in agriculture since 1995 after the establishment of World Trade Organization (WTO) has thus brought in many challenges apart from opening up new avenues for growth and diversification of agriculture.

Many of the SAARC nations like, Afghanistan, Bangladesh, Bhutan, India, Pakistan and Nepal have contiguous land boundaries and as plant pests do not recognize geographical boundaries, the free movement of agricultural products in trade and research material has opened new routes for entry of plant pests through import of seeds, planting material, plants and their products. The geographical location, climatic suitability and the diverse agricultural scenario predisposes the South Asian region to new/emerging native pests and diseases many of which have a potential to establish and cause serious economic losses. It has been estimated that globally a total of *32.2* % of losses takes place due to various pests (Oerke, 2006). In contrast, weeds are estimated to cause a 30% loss in potential crop production in India, worth about US$ 90 billion per year in reduced crop yields (Singh, 1996). Approximately 45% of the weeds in USA pastures are alien species, which account for a loss of about US$1 billion in pasture production per year (Pimentel et al., 2001). The documented information on crop losses in South Asia is unfortunately very scanty though billions of dollars are expected to be lost in the region. It is estimated that invasive alien species alone in crops and pastures in the USA, United Kingdom, South Africa, India and Brazil result in economic losses of US$ 94.92 billion per annum (Pimentel et al., 2001).

The present article is a policy paper intended to highlight status of pests and plant protection in South Asia that impinges upon biosecurity and the status of regional cooperation that exists. It then discusses the various areas of knowledge development and sharing and proposes a knowledge management strategy that can be a part of policy guidelines to ensure plant biosecurity in the region.

PESTS AND PLANT PROTECTION IN SOUTH ASIA

The major crops of the region viz., rice, wheat, maize, cassava, tea, coffee, banana, coconut, papaya and mango are attacked by a number of pests threatening food security and also the production of high value agricultural products for domestic consumption and exports.

Brown plant hopper of rice, fruit borer, stem borer, hispine beetle, fruit fly, red palm weevil, locust, corn borer, coconut mite, coconut wilt, banana viruses, wooly aphid, rusts and bunts of cereal crops, e.t.c. are only

some of the examples of economically important pests and diseases of South Asia.

The papaya mealy bug, *Paracoccus marginatus* in papaya and cassava mealy bug *Phenacoccus manihoti* of cassava are other fast spreading emerging pests (Muniappan et al., 2008).

There are certain destructive pests of important agricultural and horticultural crops of the region which fortunately have limited or restricted distribution in the region viz, coconut cadang cadang viroid, banana bunchy top virus, San jose scale, potato cyst nematode, tea stem canker, sunflower downy mildew, coffee berry borer, phloem necrosis virus in tea and pine wood nematode. The coconut mite which has been introduced from Africa to Sri Lanka and southern India and causing serious economic losses. This pest has potential to spread to other coconut countries in Asia where 85% of the world's coconuts are grown (Khetarpal and Dashora, 2011).

It is also important to note that several pests of great economic significance are yet not reported from the region on important commercial and food security crops. This includes South American leaf blight of rubber (*Microcyclus ulei*), South American fruit fly (*Anastrepha fraterculus*), Mexican cotton boll weevil (*Anthonomus grandis*), Ergot of maize (*Claviceps gigantean*), rice yellow mottle virus and maize streak virus (Khetarpal and Gupta, 2007). South American leaf blight of rubber is one of the most economically important pest not yet occurring in Asia, particularly Southeast Asia where natural rubber is playing a prime role in the economy of the country (Khetarpal and Dashora, 2011). Also, the effective quarantine processing (including germplasm) greatly contribute in limiting the transboundary spread of pests (Khetarpal, 2004).

The countries in South Asia have different level of economic and political growth, varying agroecosystem and also different level of infrastructure, expertise and regulatory system to manage the losses caused by local and exotic pests. Countries need the capacity and knowledge management systems to carry out pest risk analysis using International Standards of Phytosanitary Measures of International Plant Protection Convention (IPPC) that are framed under the purview of SPS Agreement of WTO. Hence, there are many levels of challenges in implementation and execution of disease management programmes.

REGIONAL COOPERATION

It is imperative to have regional cooperation and coordination, information sharing about new diseases and pests in the area, and the successful management strategy to reduce the spread and adverse impact of local and trans-boundary pests and diseases. The countries need to be proactive in having an early warning mechanism, a well organized Integrated Pest Management programme, domestic quarantine programmes for pests with restricted distribution, and should develop regional and national pest diagnostic network and promote interdisciplinary research and development for ensuring biosecurity and conserving biodiversity.

The IPPC with secretariat at FAO has a strong presence in each of the FAO regions, and the regional office for Asia-Pacific provides the secretariat for the Asia and Pacific Plant Protection Commission (APPPC) which was established in 1956 and has 24 countries including those from South Asia. The commission works with National Plant Protection Organizations (NPPOs) to review the state of plant protection in the region and is actively participating in development of international and regional standards for phytosanitary measures. It also coordinates a regional response to plant protection issues including transboundary pests. The commission is active in the process of capacity building in the implementation of international and regional phytosanitary standards and in promoting information exchange among its members and other countries in the region. FAO's Emergency Prevention System for Transboundary Animal and Plant Pests and Diseases (EMPRES) provides support to governments in all of these areas.

AREAS OF KNOWLEDGE DEVELOPMENT AND SHARING ON PLANT PROTECTION IN SOUTH ASIA

Regulatory and legislative

Till date, we do not have a South Asian regional policy that may highlight the importance of plant protection and quarantine for integration/harmonization of existing practices and regulatory mechanisms among countries. The system, as it exists, generally lack a mechanism and scope for networking that can promote research consortia among the existing institutions in the public, private, academic and civil society sectors engaged in monitoring, biosafety testing, quarantine and other programmes. The important areas yet not addressed include harmonization of plant quarantine regulations in the region in line with the norms of European Union (EU) countries framed by European and Mediterranean Plant Protection Organisation (EPPO) to categorize pests as A1 (not known to occur in EU) and A2 (known to occur in specific countries of EU) to facilitate trade of the region with other countries outside the region and trade among the countries of the region without compromising with quarantine requirements. List of prioritized pests of national concern are generally not available and also legislative requirements for transboundary movement of transgenic material, cell cultures, pathogens, beneficial insects and biocontrol agents has yet to be in place.

Existing lists of quarantine pests also needs to be reviewed as risks from pests change over a period of time and with the emergence of new pests (Singh et al., 2013).

There is no mechanism to jointly deliberate and review the policy issues related to Sanitary and Phytosanitary (SPS) agreement of WTO, Cartagena Protocol and invasive alien species of Convention on Biological Diversity (CBD) in international fora to better protect the common interests of the region. It would be worthwhile developing common quarantine regulations according to the norms prescribed by IPPC wherein lists of common pests present in all the countries could be prepared enabling the waiver of additional declarations in the issue of import permit. Besides, development of emergency and rapid response teams to deal with epidemic/pandemic situations arising in any member country of the region can be put into place.

Technical and researchable

The South Asian countries have yet to come forward to develop pest risk analysis with joint efforts for few common crops/pests of quarantine significance to the region. For this purpose, each country would be required to take up survey for the occurrence and distribution of pests of the common crops of the region and share the information. Strengthening of domestic quarantine programmes for pests with limited distribution for "exclusion" and "containment" of new and emerging strains of pests within the countries have to check their intra-national movement as well as transboundary movement in case of countries with contiguous land borders. Countries with contiguous borders have yet not developed programmes for eradication/declaration of pest free areas (PFA) for pests of major concern in exports from the region for continuous detection, eradication, monitoring and review.

Also, majority of the countries do not have a robust survey and surveillance programme for monitoring major pests including invasive weeds by using modern tools like geographic information system (GIS) and remote sensing for e-surveillance and simulation models for early warning within the region to check for movement of pests (such as Ug99 race of wheat rust). Besides, surveillance for natural enemies and mitigation options to deal with epidemics/pandemics of pests within the region also needs to be taken up. Development of user-friendly diagnostic kits and molecular/digital identification for common threatening pests and invasive weeds with limited distribution within the region for their effective containment has not been addressed on priority. The countries also need to develop collaborative projects/programmes in the area of taxonomy, etiology of unknown/emerging pests to deal with SPS issues in trade etc., particularly in view of scarcity of scientific and financial resources in the region.

Capacity building, extension and awareness

Capacity building needs to commensurate with the need assessment of the member countries for establishing infrastructure at the very basic level. Awareness generation is being made on the necessity to reach the farmers with actionable information through human intervention and also through use of mobiles and the need for critical mass to be trained for that purpose is now being felt. CABI, a more than 100 years old, not for profit science based organization (www.cabi.org), has launched Plant wise, a global initiative aimed at improving food security and the lives of the poor by reducing crop losses in South Asia countries (www.cabi.org). The program is broadly composed of a network of plant clinics to be established globally, and a knowledge bank comprising of worldwide data on crops and crop pests. CABI has been at the leading edge of information science and technology from its first abstract journal published in 1913. Similarly, it has helped to pioneer new approaches to help farmers and their environments, such as integrated pest management in the 1980s and recently plant health clinics and knowledge management through 'Plantwise' which provide support through national and community structures to farmers globally, who otherwise would lack reliable plant health services. Currently, there are clinics operating in India, Bangladesh Sri lanka and Nepal. The clinics, operated by trained local personnel, advise farmers on pests in a manner similar to the way a health center does for humans. Another initiative is the mobile agro-advisory services wherein there are presently around 5 million farmers in 8 States of India as their subscribers. Farmers can use the mobile phones and mobile phone based applications, for real-time expert advisory, receiving pro-active warnings or uses it as a tool for establishing effective market linkages. This is very critical for farmers who live in places which are dispersed, difficult to reach or isolated.

Besides, countries have yet to develop a strong programme of awareness generation on biosecurity for various stakeholders such as academia, policy makers, custom officials, students and general public. In nutshell, there is a need for enhancing the national and regional biosecurity engagements.

IMPORTANCE OF KNOWLEDGE MANAGEMENT FOR PLANT BIOSECURITY IN SOUTH ASIA

The problem of plant disease, particularly in developing countries, is aggravated by the dearth of resources devoted to their management. This may be as a result of poor governance but it also arises from the difficulty of quantifying plant disease and relating this to the failure to reach achievable yields. The pace of research and development had been reasonable in plant protection, but this stream of science in relation to its importance, continues to be grossly overlooked by the policy makers probably because of the lack of appropriate data on economic losses. Besides, technically the major constraint

faced by plant protection specialists is the correct identification of the causal agents to the species level. The need for correct identification of plant pests and pathogens can hardly be exaggerated since it is fundamental to control. Fortunately, a number of tools are available which enable to narrow down the findings and assist in coming to appropriate conclusions. At the field level, there are a certain compendia developed by CABI like CABI's Crop Protection Compendium and CABI's invasive species compendium beside the globally known CAB abstract, which equips the researcher to have rich and validated information.

Presently, a sectorial approach is being adopted to address the issues of biosecurity (Swaminathan, 2008) and this is true more so in South Asian countries. There is a lack of integrated approach to deal with its various components. The countries do not have their information on various aspects of plant protection that impinges upon plant biosecurity at one platform. To begin with there is a need for a strong legislative mechanism, reorganization of infrastructure facilities and synergy of expertise from various organizations under the different concerned ministries (Agriculture, Environment, Commerce, Tourism etc), databases of pests and diseases, research findings and the extension programmes all at one place.

South Asia countries have varying strength in terms of regulation, institutions, infrastructure, expertise and funding for plant health management in its national programmes. There are number of Acts related to biosecurity and biodiversity impinging upon plant health management. The Ministry of Agriculture in South Asia countries do have national programmes on quarantine, integrated pest management, registration of new molecules, locust and rodent control and capacity building. Besides, in some countries there are large numbers of research institutions and universities for a technical back-up to the ministries programme on extension and development. As an example, India has one of the largest agricultural scientific manpower in the world spanned across 99 Institutes of Indian Council of Agriculture Research and 70 State Agriculture Universities many of which deal with plant health management. There are also large numbers of R&D on plant health management by various private corporate of national and multinational origin. Also it has been observed that South Asia, is recently becoming increasing aware of integration of its policies, research, general plant protection measures and quarantine to develop an effective plant health management system. India has already ventured into a National Agricultural Biosecurity System, the recent outcome of which is the Integrated Agricultural Biosecurity Bill which is now tabled in the Parliament.

It is thus amply evident that in order to manage the growing technical, regulatory and infrastructure needs for an efficient biosecurity system a national hub on knowledge bank needs to be envisaged.

KNOWLEDGE MANAGEMENT STRATEGY

A constant threat from pests and diseases hangs over South Asian countries thus challenging the biosecurity system that are still not in place in the real sense as mentioned above. It is thus important to move in the following direction:

1) The countries need to strategize to develop an integrated communications and knowledge management approach for plant health to cover policies, regulations, diagnostics, certification, surveillance, early warning systems, forecasting, teaching, training, etc. Ensuring that the relevant audiences know where to find and how to access and use these significant knowledge resources is a challenge, but essential to build evidence based policy and interventions. A national knowledge resource would help deliver appropriate and customized information for policy makers, researchers and those implementing the public and private sector programmes. Any knowledge resource should aim to collect and collate the rich but scattered and often inaccessible information on a single platform; information should be customized to stakeholders in trade, field management, academia, etc., making it accessible to key national and international actors engaged in enhancing food production.

2) It would be of immense use in exploring the development of a 'knowledge repository' in biosecurity in a partnership mode. A knowledge repository should cover the broadest possible range of plant health issues from pre-crop to on-farm and postharvest issues and cover transboundary diseases. A pilot study would at first have a restricted scope; a focus on a limited range of crops, which also have export potential and where the impact of a reduction in crop losses can also be measured in terms of increased export earnings. The 'knowledge repository' should document the latest research information published and of relevance to South Asian countries and present analyses of research knowledge thereby helping to direct future research agendas. Survey information will help in the surveillance of pests and diseases in the region and assist in risk analysis and pest and disease management; potentially in association with new plant clinic networks. The site and associated activities will support capacity building in plant health management, and support those capacity building activities being carried out by relevant organizations.

3) It is imperative in the interest of the food security and economy of the region that the countries come together To brainstorm on the very need for developing a knowledge management platform for biosecurity where the more countries who are more advanced in the field such as India may take a lead through platform of SAARC or other regional bodies.

CONCLUSION

The knowledge management hub in plan biosecurity will

not only permit to collate and harness the information on pests but will also lead to capture the market for export as well be able to customize information as per requirement. This will also lead to a timely and accurate diagnosis of pests and will thus it will be an indispensable tool for early warning system and for developing a rapid response strategy in case epidemics break out. The South Asia countries need to come on one platform to strategize collectively in this aspect to harness the natural and knowledge resources in the region to ensure an effective plant biosecurity in the region. For this, the countries/organizations need to align their strategies with the knowledge base of the country by keeping pace with technology and using SAARC, Asia Pacific Plant Protection Commission and other regional bodies as a platform to achieve the objectives. What we need is just a political and a professional will to begin with.

Conflict of Interest

The author(s) have not declared any conflict of interest.

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