Agrobiodiversity Index : Role in Germplasm Collection and Conservation

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Introduction

To provide an easily understandable status of agrobidiversity of particular area to the policy makers, private companies and researchers instead of providing the numbers (crops/species/population), there was a need to develop cost effective and rapid method, accounting it's all components. In this regard, the agrobiodiversity index (ABI) was first time proposed by the Bioversity International in first International Agrobiodiversity Congress held in New Delhi, during 6-9th November, 2016 and "Delhi Declaration on Agrobiodiversity Management" called for this index to help monitor conservation and use of agrobiodiversity. Besides providing agrobiodiversity status, the index would also help the policy makers and stakeholders to decide appropriate interventions, investments to ensure sustainable and nutritious food system. The concept emerged from the publications compared the 'levels of crop diversity produced' with 'levels of crops diversity imported'. The analysis of both levels of diversity could yield novel and practical insights for their sustainable management. Agricultural biodiversity (agro-biodiversity) "includes the variety and variability of animals, plants and micro-organisms that are used directly or indirectly for food and agriculture, including crops, livestock, forestry and fisheries." (FAO, 2005). Hence, agrobiodiversity includes a large number of economically important plants and animals associated with agriculture, fisheries and forestry.

The development of agrobiodiversity index is still at its infancy because it requires integration and accounting of a large number of components of agroboidiversity, decide their share in the index, develop and refine its methodology etc. Further, dynamic nature of agrobiodiversity would limit its applicability to a certain period followed by data collection. The Bioversity International is making good efforts on developing its methodology integrating all the components of agrobiodiversity and this write-up gives an insight about the agrobiodiversity index given recently by it. Initially, it would be rational to develop the index on a limited scale covering block and district level- as a case study, refine the methodology and further up-scale at larger or a country level. This index at broader level will indicate the level of agrodiversity available and used in different countries and may help in categorising them from rich to poor diversity, while with-in country it would help in identifying the areas, states, districts having and using agrodiversity at different levels. This information will help in collection and conservation of agrodiversity, and make area specific plan for better management.

Role of Agrobiodiversity

Agricultural biodiversity is the backbone of sustainable agricultural intensification including different components of farming systems like agroforestry, crops and cropping systems, orchards, live-stock, fisheries, poultry etc. It provides food and raw materials for goods - such as cotton for clothing, wood for shelter and fuel, plants and roots for medicines, and materials for biofuels - and with incomes and livelihoods, including those derived from subsistence farming. It also performs ecosystem services such as soil and water conservation, maintenance of soil fertility and biota, and pollination, all of which are essential to human survival. Agro-biodiversity plays critical role to the attainment of the Sustainable Development Goals and Convention on Biological Diversity's targets. It plays a major role in combating climate change and halting biodiversity loss by the means of genetic diversity that provides species with the ability to adapt to changing environment and evolve, by increasing their tolerance to frost, high temperature, drought and water-logging, as well as their resistance to particular diseases, pests and parasites. It is crucial in conservation of genetic diversity of cultivated plants, crop wild relatives and domesticated farm animals etc.

Challenges Ahead

Focus on increasing food production without due concern to the environment is causing severe land and water degradation, particularly in some areas of northern India having good fertile soil and abundant water. Today's food systems are failing on both the consumption and production sides. Dietary diversity is decreasing, produce of high yielding varieties generally has low nutritional quality. Malnutrition is affecting one in three people on the planet. Contrary to it, remote and tribal areas still have, maintain and use more diversity, nutritious and organic food. Production of fruit and vegetables provides only 78% of the world population's nutritional needs. Agriculture contributes around 24% of the world's greenhouse gas emissions and it is single largest user of fresh water on the planet. Water table in Punjab, Haryana, Western U.P. and Rajasthan have decreased to very deep level, and in some areas problem of saline and arsenic in water have emerged. The Earth's biodiversity is being lost at an alarming rate, putting in jeopardy the sustainability of agriculture and ecosystem services and their ability to adapt to changing conditions, threatening food and livelihoods security. Climate change is a major challenge, its impacts on agriculture are being witnessed all over the world, but countries like India are more vulnerable due to huge population dependent on agriculture. The warming trend in India over the past 100 years has indicated on increase of 0.60°C. The projected impacts are likely to further aggravate field fluctuations of many crops thus impacting food security. There are already evidences of negative impacts on yield of wheat and paddy in parts of India due to increased temperature, water stress and reduction in number of rainy days. Research has shown that crop yields are quite sensitive to changes in temperature and precipitation, especially during flower and fruit development stages. Diversified agro ecosystems have become more important for agriculture as climate fluctuations have increased. Changes in landuse, shrinking areas of agriculture land, forest cover, natural resources particularly glaciers, drying of rivers etc. aggravating the problems. Adoption of Integrated Farming Systems (IFS) that ensure food & nutritional security, regular income and year round employment, conserve agrobiodiversity and natural resources, maintains soil quality for sustainable agriculture, and minimize the risk of failure in productivity, would be best approach to combat these problems.

What Needs to be Done?

Assessment of the status and trends of agricultural biodiversity and knowledge of underlying causes of change are key requirement for long-term planning and sustainable manage the production systems and ecosystems for their adaptive, evolutionary sustenance. Knowledge of management practices, identifying adaptive management techniques, practices and policies are crucial in meeting the growing demand of food and sustainable maintain the agrobiodiversity. Building capacity, increasing awareness of conservation and promoting responsible action among the stakeholders are very important. National plans, policies and strategies must integrate the mainstreaming of agricultural biodiversity conservation and sustainable use. Collection for preservation, research and use of agrodiversity would build upon the knowledge of the status of diversity present in the area.

Pros and cons

The variety in measurements related to agricultural biodiversity is both its strength and its weakness. Its strength: because data on agricultural biodiversity's contribution to each of these goals is collected and it raise the awareness across relevant sectors, Sustainable Development Goals and the Convention on Biological Diversity Aichi Targets. Its weakness: because the data, information and metrics are scattered across disciplines (e.g. conservation, ecology, agriculture, markets, nutrition) and scales (from crop varieties to species to ecosystems). There is a gap in terms of tools and approaches for quantitatively synthesizing existing and emerging data into actionable trends, dynamics and summaries. This limits the effective management of agricultural biodiversity to contribute to sustainable food systems.

Calculating an Index

Index numbers provide a simple, easy-to-digest way of presenting various types of data and analyzing changes over time. An index measures changes against a base value in a simplified fashion. Working with a group of large numbers is sometimes inefficient and confusing, and an index allows to use a simplified value to easily compare and track against other data points over time. An index starts with a base value, typically may be set at 100, regardless of whether the index measures data units in numbers, area or headcount. Each subsequent value in the index is then normalized to this base value. When looking at the percent change between different calculated index values, you will find that it's exactly the same as the un-normalized or non-indexed data percent change. Using an index to measure changes in data allows us to calculate the percentage change between the points in the index without the need to know the actual data numbers. The index points become normalized when dividing each number by its base value, meaning that the values on different scales become converted into a common scale for ease of comparison.

Agrobiodiversity Index - New Tool

The Agro-biodiversity Index is a new tool to measure food system diversity and sustainability. It is a consistent long-term tool to measure and manage agro -biodiversity across four dimensions: nutrition, production, seed systems and conservation. The Delhi Declaration on Agrobiodiversity Management, adopted at the first International Agrobiodiversity Congress, held in November 2016, called for "an agrobiodiversity index to help monitor conservation and use of agrobiodiversity." Up to now, there has been no consistent way for governments, private sector and other decision makers to assess agro-biodiversity in food systems, track changes, or measure the influence that it has on other issues and sectors. It will be useful to decision-makers – governments, investors, companies, farmers and consumers – to ensure food systems that are more diverse and sustainable. It will guide and stimulate public and private sector investments in agrobiodiversity for sustainable food systems. It will enable decision-makers and planners to manage agrobiodiversity, make and guide policies, and support the programmes that deliver diverse healthy diets, provide multiple benefits to sustainable farming systems and develop area specific seed systems delivering crop diversity for sustainable food systems. It will provide policymakers and private investor's easy-to-follow evidences to link decisions across human nutrition, environmental protection, agricultural production, biodiversity conservation and economic development. The over-all index value of particular area would be a good indicator of the agricultural biodiversity conserved and food systems sustainable maintained.

Other indexes

Some well-known examples of index include the Consumer Price Index (CPI) and Stock Exchange Indexes. Different types of indexes can be distinguished based on the audience targeted and the data used. One type uses national datasets, aggregates well-established indicators, and mainly targets national governments. Examples are the Global Biodiversity Outlook, Global Food Security Index, Global Hunger Index and the Environmental Performance Index. For biodiversity measurements, the Simpson's Diversity Index and Shannon Diversity Index are commonly used to measure the species richness, abundance and evenness at community level.

Data and analysis

Like other indices, ABI would also use regional and national datasets, aggregates of well-established indicators, and mainly target the national governments. It will comprise a set of measures to apply across four inter-connected dimensions of diets, production, seed systems and conservation. Parameters at different locations by different actors will be used to provide insights into agrobiodiversity trends. Overall index would build upon the composite and sub-indices. In return it will provide key data for allocation of financial resources, to measure progress towards

relevant targets in the Sustainable Development Goals and the Convention on Biological Diversity. Many datasets exists, collected at great expense but often found overload of information by the users. Hence, dataset most relevant to answer specific and desired questions are useful. Indices that are able to filter, prioritize and manage the data to make them useful, manageable in decision support system are in demand.

Agro-biodiversity Index in Collection and Conservation of Germplasm

Agricultural biodiversity is wide ranging, includes all species and their genetic diversity that are of relevance to agriculture, plus landscape diversity, microbiological diversity in the soil etc. As the globalization and homogenization of diets and farming systems are the greatest threats to agricultural biodiversity, out of 40 animal species and 5538 plant species documented as human food only five animal and 12 crops species now provide 75% of the world's food. Conservation of agricultural biodiversity for sustainable food systems is one of the aims of Agrobiodiversity index, the genetic resources would be ideally conserved within three broadly interconnected realms.

i. On-farm diversity: is managed by farmers on farm and thus allowing response to natural and human selection.

ii. *In-situ* diversity: occurring in natural habitats, under selective forces of nature.

iii. *Ex-situ* diversity*:* that has been collected, conserved, and managed in offsite facilities *e.g.* genebanks, seed banks etc.

Measuring and Management of Diversity

Based on the world-wide observations, the Bioversity International, has identified four important dimensions of agrobiodiversity: in nutritious diet and human health; in production system for long term productivity, resilience and ecosystem services; in seed system to serve diverse need and help adaptation to changing conditions; and in integrated conservation methods for future use and insurance against shocks. Many indicators and methods have been given to measure agricultural diversity. The metrics identified to measure different components of agrobiodiversity under these four dimensions are given in following tables:

Existing and proposed indicators to measure agricultural biodiversity and its contributions to dimensions in a sustainable food systems:

i. Indicators for measuring nutritional diversity

Sl. No	For improving health and nutritional value	Indicators
1.	Healthy diet	• Minimum diet diversity for children and women • Percentage consumption of targeted food groups • Dietary species richness • Grams and dietary energy per capita of different food groups • Percentage dietary energy from non-staples
2.	Market/value chain diversity	• Prices of principal foods representative of diverse food groups • Ultra processed food retail (vol/capital) • Fresh food retail (kg/capital) • Diversity of retail outlets for elements of a healthy diet • Average price of a healthy die

3.	Enabling environment	• Consideration of Agrobiodiversity index in a country's national dietary guidelines • Food subsidies and public procurement programmes in place that promote Agrobiodiversity for diets/nutrition • Consideration of index in mainstreaming for diets/nutrition

ii. Indicators for measuring sustainable farming systems

Sl. No	For sustainable farming systems	Indicators
1.	Inter & intra-species diversity	• Varietal diversity of major crops in production systems • Diversity of production area and yield across crops
2.	Field level diversity	• Soil biodiversity in agricultural production systems • Functional trait diversity of crops • Percentage of agricultural area under sustainable agricultural practices • Land use pattern, coverage of habitat related to particular ecosystem services
3.	Enabling environment	• Policies aiming to conserve and/or promote ABD • National policies and incentives around multiple ecosystem services in agricultural sector.

iii. Indicators to measure crop diversity for sustainable food systems

Sl. No	Crop diversity	Indicators
1.	Accessibility of seed	• Information on availability of seed • Amount diversity of seed sources • Seed prices and proximity of seed source
2.	Production and distribution of seed	• Quantity of seed produced and distributed, and number of farmers catered • Number/range of crops and varieties multiplied and distributed • Number and diversity of seed multipliers and distributors
3.	Crop improvements and regulations	• Range of species covered and genetic diversity used in crop improvement • Farmers varieties registered and number of farmers recognised as innovators • Varieties released for different environmental and socio-economic conditions • Number of seeds producers and farmers facilitated by the seed quality control and seed certification schemes

iv. Indicators to measure conservation and use in sustainable food systems

S. No	Mode of conservation	Indicators
1.	On -farm	• Percentage of cultivated land under farmers' varieties/landraces in areas of high diversity and/or risk • Number of local breeds by species and region

2.	*In-situ*	• Trends in population size of target Crop Wild Relative population • Crop Wild Relative Index based on IUCN Red Listing
3.	*Ex-situ*	• Number of species conserved ex situ under medium or long-term conditions • % crop species native or exhibiting a wide diversity conserved in ex situ collection • Enrichment Index

Agrobiodiversity Index- Decision maker

ABI may act as a catalyst for the companies implementing sustainable business practices that increase long-term shareholder value by both reducing risks in the supply chain and enhancing attractiveness to consumers. It will provide key information to the governments pursuing sustainable development by investing in progressive food, agriculture and conservation actions and monitoring country progress towards global goals. Private investors willing to invest in Green Bonds, Carbon credits, contributing capital to sustainable environmental and climate-focused development projects.

Current Status

Bioversity International is currently working with interested countries and corporations to develop an Agrobiodiversity Index to measure and manage agricultural biodiversity across four connected above mentioned dimensions. Developing index for all agrobiodiversity indicators is still in pipeline. Initially the Bioversity International, has taken two countries i.e. Ethiopia & Peru on experimental and as pilot projects basis. India is also under consideration to initiate the process of developing index. However, while taking this task, it has stated that no index is perfect and there is always space for improvement. Further, from user perspective the index should steer progress on intractable challenges. The composite indices address multiple dimensions of certain issue, while overall index mainly attract attention and comparative performance. The sub-indices allow policy makers to identify entry points for action. Finally, the development of robust indices takes time, adapted by lessons learned, iterated and improved by engaging end users.

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Agrobiodiversity Index is a new and recent concept hence most of the information has been drawn from the lectures and publication of its proposer “Bioversity International” for the benefit and knowledge of the trainees of PGR Management at ICAR-NBPGR, and hence its contribution is duly acknowledged.

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