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# Role of traditional ethnobotanical knowledge and indigenous communities in achieving Sustainable Development Goals

**Authors**

Ajay Kumar[1,*], Sushil Kumar[2], Komal[3], Nirala Ramchiary[4], Pardeep Singh[5]

**Author Affiliations**

[1]Department of Plant Science, School of Biological Sciences, Central University of Kerala, Periye-671316, Kasaragod, India.

[2]Department of Botany, Degree College, Ramnagar, University of Jammu, Jammu-182122, India.

[3]Department of English, Govt. Degree College, Bani, Kathua, Jammu and Kashmir, India.

[4]Translational and Evolutionary Genomics Laboratory, School of Life Sciences, Jawaharlal Nehru University, New Delhi-110067, India.

[5]Department of Environmental Science, DAVV College, University of Delhi, India

Authors for correspondence*: botanistajay@gmail.com; ajay@cukerala.ac.in [Ajay Kumar]; nrudsc@gmail.com [Nirala Ramchiary]

**Author email addresses**

Ajay Kumar (botanistajay@gmail.com); Institutional Email ID: ajay@cukerala.ac.in

Sushil Kumar (sushilthakur863@gmail.com)

Komal (komalkanthalia108@gmail.com)

Nirala Ramchiary (nrudsc@gmail.com)

Pardeep Singh (pssinghpardeep@gmail.com)

**One sentence summary**

Traditional ethnobotanical knowledge combining with modern science can contribute significantly to achieving at least 7 sustainable development goals.

## ABSTRACT

Sustainable Development Goals (SDGs) envisaged under Agenda 2030 are a set of seventeen goals which envisage a holistic approach towards attaining certain targets keeping humankind and the planet at center. There are total 169 targets spread across seventeen goals covering wide ranging issues and challenges the world is facing in the twenty-first century. And they are to be achieved by 2030. Concerted efforts of all the stakeholders ranging from indigenous communities, common citizens, scientists, policy makers, world leaders are needed to achieve all the goals and targets Of the seventeen goals, at least seven goals are of interest to the ethnobotanists and are associated with traditional ethnobotanical knowledge. Therefore to achieve those set of goals, a thorough understanding is required to disentangle the intricacies involving traditional ethnobotanical knowledge, indigenous people as traditional knowledge holders and their future role. Understanding relationships between traditional ethnobotanical knowledge and indigenous communities, seeking cooperation from and establishing partnerships with them would help us design policies to achieve intended outcomes of SDGs. In this paper, particular attention is attracted towards the potential role of traditional ethnobotanical knowledge in achieving select sustainable development goals and targets.



**Keywords**

Sustainable Development Goals, Ethnobotany, Human Health, Poverty, Traditional Knowledge, Sustainable Agriculture

## 1. INTRODUCTION

The United Nations General Assembly in its 70$^{th}$ meeting on 25$^{th}$ September 2015 adopted a resolution "Transforming our world: the 2030 Agenda for Sustainable Development" (UNGA 2015). Member countries adopted 17 set of goals called Sustainable Development Goals to end poverty, protect the planet, and ensure prosperity for all. Each goal has specific targets to be achieved by 2030. Sustainable Development Goals are an extension of Millennium Development (MDG's) Goals and part of a new sustainable development agenda to complete what they (MDG's) did not achieve (ICSU 2015). For the goals to be realized, everyone needs to do their part; governments, the private sector and civil society.. Though the Agenda 21 of the Rio Earth Summit in 1992 (UNGA 1992) where the concept of sustainable development emerged, advocated the pivotal role of indigenous' people and other local communities, in environmental management and development because of their knowledge and traditional practices **(**Kimerling 2002**)**, the official UN document of 2015 has not explicitly recognized the role of ethnobotanists in achieving these sustainable development goals. Apart from the role of different countries and various stakeholders mentioned in the document in achieving these goals and targets, we advocate and reiterate the role of indigenous communities by recognizing and duly supporting their identity, culture and interests and by enabling their effective participation in the achievement of sustainable development goals as mentioned in the Principle 22 of the Rio declaration on Environment and Development, 1992 (UNGA 1992). We reaffirm that traditional ethnobotanical knowledge, ethnobotanists and people's participation can significantly contribute to achieving sustainable development goals by 2030 and beyond. People have a long history of interactions with the plants for various purposes such as food, medicine, decoration construction and clothing (Balick 1996**)**. The usage of plants for various purposes by the indigenous and local communities comprises traditional ethnobotanical knowledge. The traditional knowledge on the usage of plants is not well documented formally by indigenous people as it is orally and vertically transmitted from generation to generation (Garnatje, Peñuelas, and Vallès 2017a).

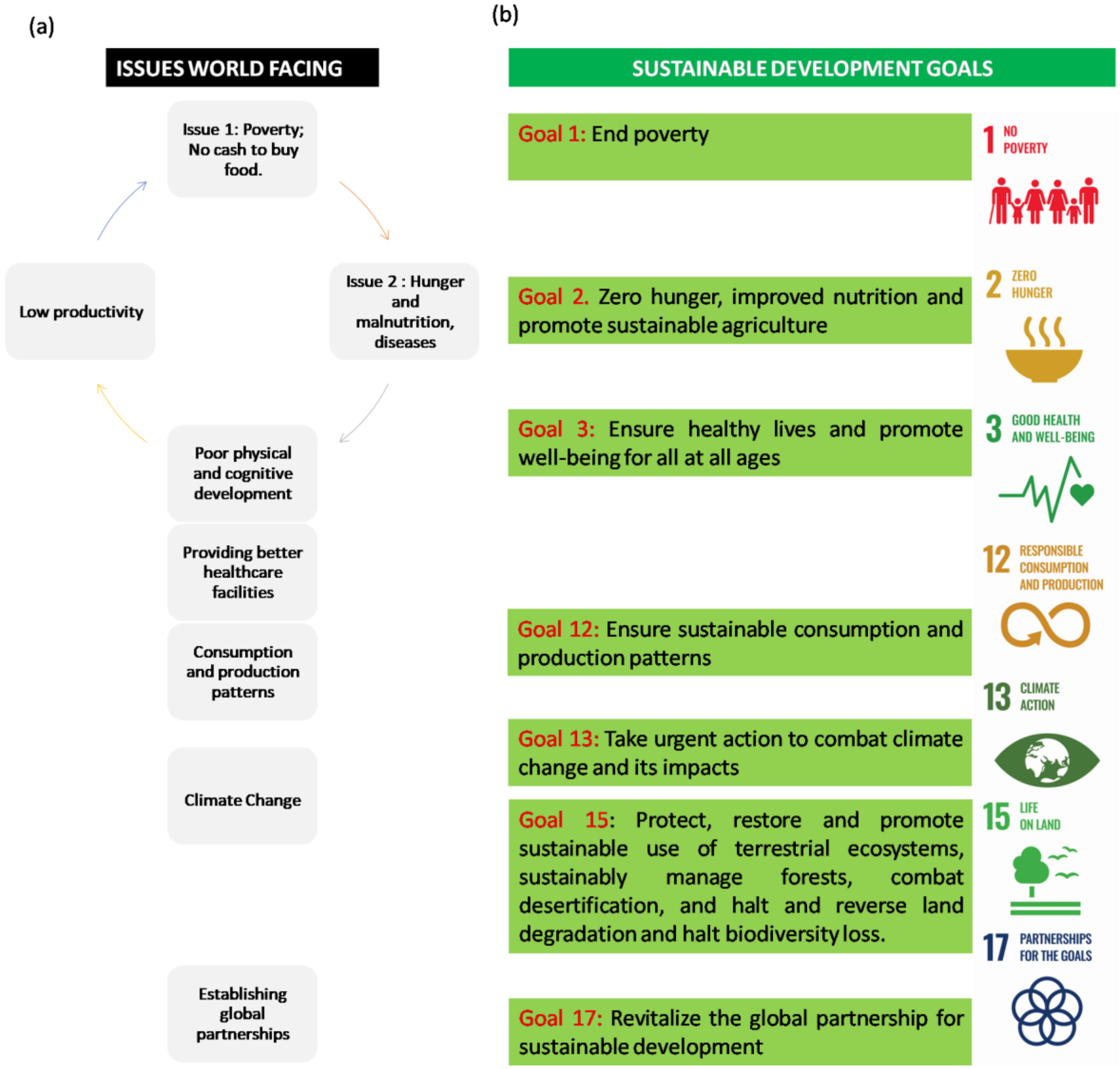


**Figure 1:** Major issues and challenges world facing in the present century [a] and the vision of the Sustainable Development Goals post 2015 MDG. Of the total seventeen goals envisaged under SDG's, ethnobotanists can contribute significantly to the seven set of goals as summarized [b].

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Though it is transmitted orally, ethnobotanists have played an important role in unravelling these plant-people interactions and in unlocking the knowledge by various types of interviews and surveys. Apart from interviews and surveys, recently archaeological, palaeontological and archaeogenomics evidence have also been used to establish the plant-people interactions from the prehistoric times (Allaby *et al.* 2015, Liu *et al.* 2013, Mercader 2009). Though records on the consumption of plants by humans in the prehistoric times are scarce, recently it has been discovered that people in South Africa used leaves of *Cryptocarya woodii* for construction of bedding 77,000 year ago and it has now been established that this plant is toxic to mosquitoes because of its larvicidal properties (Wadley *et al.* 2011). Retrieval of a large assemblage of starch granules from the surfaces of Middle Stone Age stone tools from Mozambique suggests that early humans consumed grass seeds. These records date back to at least 105,000 years ago (Mercader 2009). The discipline of ethnobotany works at the intersection of plants-people at one end and science at the other end, therefore ethnobotanists can act as a bridge between the plants-people and science (Alexiades 2003). Tuxill & Nabhan (2001) have suggested that ethnobotany can act as a useful vehicle for development and can also serve as a useful process in development. The outcomes of the interactions between the plants and people as deciphered by ethnobotanists holds a large potential to solve some of the issues the world is facing today. The common global challenges range from ending poverty, achieving zero hunger, improving the nutritional status of the people, promoting sustainable agriculture, improving the health status of the people, providing affordable health care services, combat climate change (FAO 2016, UNSD 2017). In the present review article, We have identified seven sustainable development goals, where traditional ethnobotanical knowledge can contribute significantly. The select seven goals associated with traditional ethnobotanical knowledge are; SDG 1 (No poverty), 2 (Zero hunger), 3 (Good health and wellbeing), 12 (Responsible consumption and production), 13 (Climate action), 15 (Life on Land) and 17 (Partnerships for the goals). In the following sections, a brief background to the major challenges (Figure 1a) which SDG's seeks to achieve by 2030 (Figure 1b) and then we present how ethnobotany can contribute to achieve these goals and targets (Figure 3).

## 2. POVERTY-HUNGER-MALNUTRITION CONUNDRUM AND THE ROLE OF WILD FOOD PLANTS

The current rate of population growth translates directly into increased numbers of consumers and increased demand for goods and services (Newson *et al.* 2013). The Agenda 2030 seeks to end poverty (SDG1), achieve zero hunger and improve nutritional status of the public (SDG2). Poverty, hunger and nutrition are three interlinked issues having cause and effect relationship and they need to be addressed systematically and in an integrated manner. Targeting poverty alone may help to achieve zero hunger, but unless people have access to nutritional food, simply targeting poverty may not deliver expected results. Therefore initiatives for alleviating poverty must be coupled with addressing the issues related to diet related malnutrition and under nutrition. It has been estimated that, approximately one billion poorest people of the world remain undernourished today, and by 2050, the Food and Agriculture Organization estimated that we will need to increase food production by 70% to feed the 9.1 billion people (FAO 2009). This data suggests the gravity of challenges the world is facing to ensure food security for all.

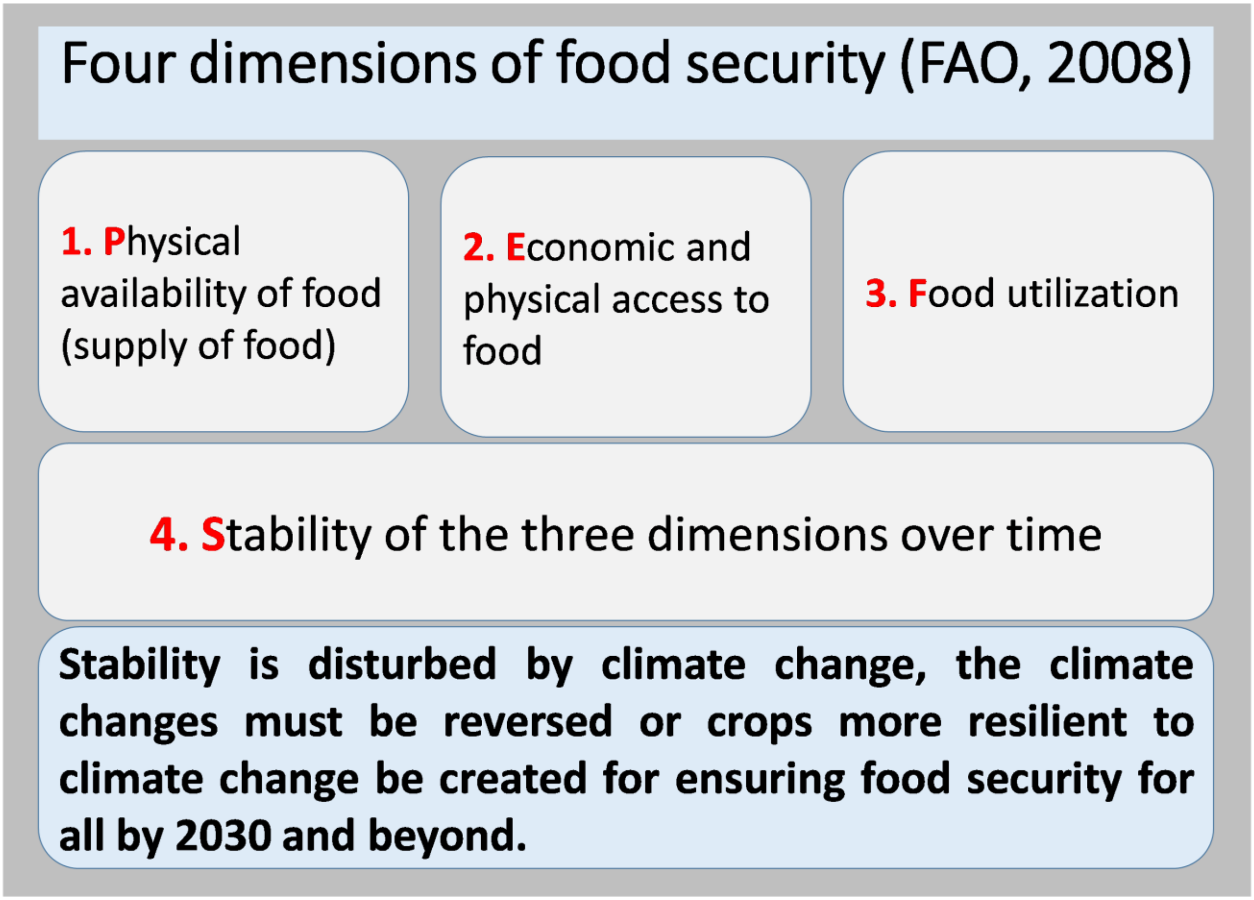


**Figure 2:** The four dimensions for ensuring food security for all [After FAO 2008]; physical availability of food (supply of food), economic and physical access to food, food utilization and stability of the other three dimensions over time. Fourth dimension i.e. stability of the three dimensions is very important. Climate change has strong bearings on the stability of the first three dimensions. The local and ethnobotanical usage of the plants are in congruence with the four dimensions defined by FAO. As the plants are locally grown and they are not affected much by climate change or diseases. The plants can be used to diversify the current food basket of the world. By adding up and mainstreaming wild vegetables and crops can ensure stability of supply-demand equilibrium which ensure economic stability.

As per FAO (2008), food security has four main dimensions; (1) physical availability of food (supply of food), (2) economic and physical access to food, (3) food utilization and (4) stability of the other three dimensions over time (Figure 2). The ethnobotanical consumption of wild vegetables and other food plants by indigenous communities are in congruence with the above four dimensions as locally grown wild vegetables can help increase the supply of food which helps maintain demand-supply equilibrium. Since the wild food plants are cultivated and consumed locally by people, the change in the prices of the market foods do not affect the economic access to it. Besides this, the plants are locally grown and they are adapted to particular environmental conditions, they are more resilient to climate change for their suitability to the local agro-climatic conditions (Talberth and Susan 2012). Some researchers have emphasized the urgent need to diversify and expand the food basket of the people under unpredictable climatic conditions (Dwivedi *et al.* 2017), wild food plants can be used to achieve this goal in diversifying the existing food bucket of the world by mainstreaming wild food plants. Since the locally grown plants are rich in vitamins and micronutrients, they can help in reducing diet related malnutrition considerably. Ethnobotanists have already generated immense data on the use of wild plants for food. A search on Google scholar titled “wild plants as food” shows 1,220,000 results (custom range was set 2000-2017). This signifies that many wild plants have already been documented which are already under consumption by various indigenous communities, the present challenges of food insecurity necessitates the mainstreaming of wild food plants and their formal addition into the existing food basket of the public by scientifically validating the nutritional composition, by studying the mode of their multiplication, the aspects such as what are the *ex situ* requirements for their germination and cultivation? To achieve this, multidisciplinary approaches needs to be employed such as the use of agronomy, plant science, phytochemistry, dietetics, and other modern analytical approaches for nutritional profiling, potential health effects also needs to be understood for some of the plants may have the presence of harmful compounds which may exert negative side effects on humans. Combining multidisciplinary approaches along with the clues obtained from ethnobotanical data on wild plants for consumption as fruits and vegetables can provide alternative options and aid in diversifying the food basket of the people. The issue of food security can be catered by popularising and mass propagation of the locally grown plants especially in the developing countries in Africa and Asia. This will enable people to be less reliable with only a few options available for their nutritional purpose. In the long run, apart from the role of wild food plants in the diversification of food basket, it can also act as a valuable genetic stock for the crop improvement programs as some of the food plants consumed indigenously are crop wild relatives (CWR's) of the presently consumed domesticated crops.

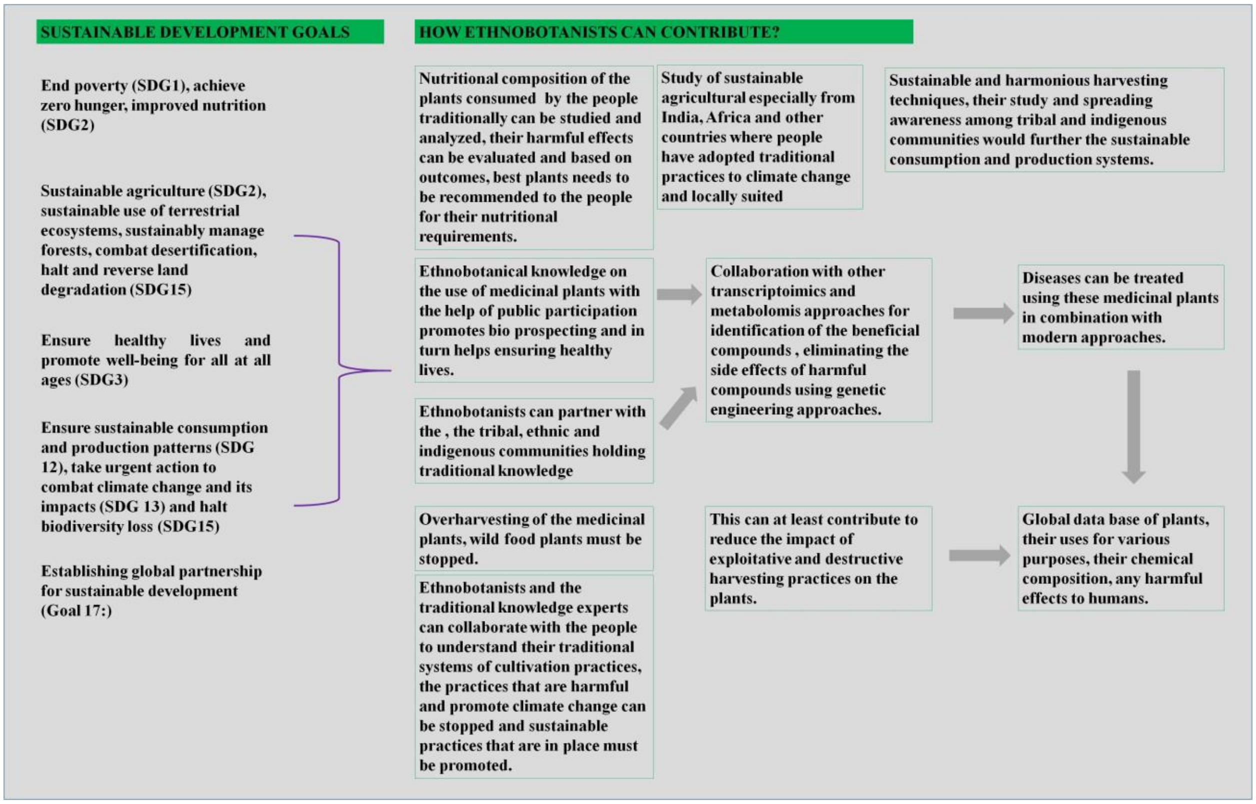


**Figure 3:** A schematic of how ethnobotanists can contribute to achieving seven set of goals.

## 3. OVERUSE OF CHEMICALS IN AGRICULTURE, DESERTIFICATION, LAND DEGRADATION AND NEED FOR SUSTAINABLE AGRICULTURE

Increase in demand for nutritious, safe and healthy food for burgeoning population, and the promise to maintain biodiversity and other natural resources, are posing a major challenge to agriculture that is already threatened by a changing climate (Dwivedi *et al.* 2017) and excessive use of chemical fertilizers and pesticides. The excessive use of fertilizers have rendered soils unfit for agricultural purposes, its long term use have increased the salinity of the soils, and reduced the total land available for cultivation of crops. This problem of soil degradation is severe in tropics and subtropics, and it has been estimated that this has decreased soil ecosystem services by 60% between 1950 and 2010 (Leon and Nelson 2014). Soil degradation has reportedly affected as much as 500 million hectare (Mha) in the tropics (Lamb, Erskine and Parrotta 2005), and globally 33% of earth's land surface is affected due to land degradation (Bini 2009, Lal 2015). Besides agronomic production, soil degradation can also slow down economic growth especially in countries where agriculture is the major engine for economic development (Scherr 2001). The use of chemical pesticides have a deteriorating effect on the non-target insects such as honey bees and other beneficial insects (Quarles 2008a, Quarles 2008b, Stokstad 2012). Pesticides can affect bee population directly by causing mortality and through sublethal effects on their behaviour. Sublethal pesticides also interfere with brood development and shorten the life cycle of adults (Quarles 2011). An unusual phenomenon was observed in the US in 2006 termed colony collapse disorder (CCD), bees disappear from the hive leaving food, brood and queen (Quarles 2008a, United States House of Representatives Subcommittee on Horticulture and Organic Agriculture 2008). It has been established that many factors might contribute to CCD but pesticides play a synergistic role in this disorder (Quarles 2008a, Spivak,

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Eric and Mace 2011, United States House of Representatives Subcommittee on Horticulture and Organic Agriculture 2007), however interestingly organic beekeepers did not face such CCD like situation (Schacker 2008). Increased use of pesticides can lead to reduced food production endangering our food security (Schacker 2008). The fertilizer and pesticide runoff have also adversely affected quality of surface and groundwater (Aktar, Sengupta and Chowdhury 2009). Thus total land available for cultivation is reduced due to its degradation caused by various activities such as water and wind erosion, salinity, sodicity and alkalinity which has lead to reduced soil fertility, urban expansion is also major form of land degradation, removing large areas of the best agricultural land from production (FAO 1995). The productivity of land available must be increased using practices which are sustainable, the conservation of the remaining land resources and reclamation of the degraded land are some of the challenges in land use and sustainable agriculture (Bhan 2013, Spiertz 2013, Winterbottom *et al.* 2013).

Besides achieving zero hunger and improved nutrition, SDG2 also seeks to achieve sustainable food production systems (Sustainable agriculture) and implement resilient agricultural practices that increase productivity and production and that help maintain ecosystems. Through intimate association with the plants and agriculture related activities, people have gained tremendous knowledge on the various aspects of agriculture and the crops. The knowledge ranges from the soil types, season of sowing a particular crop, the water and nutrient requirements, the other conditions which promote or limit productivity. The knowledge also pertains to the diseases caused by pathogens and attack by pests and their management strategies. The ethnobotanical knowledge is vast and is non uniformly distributed and locally suited as per the environmental conditions and the availability of particular crops (Brush 1992, Brush 2005). In addition to lack of proper documentation, some researchers (Wolf and Medin 2001) have suggested that

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increased modernization may have led to loss of this knowledge in many places. Turner and Turner (2008) have ascribed some other reasons to this loss which include dynamism and changing knowledge systems, loss of indigenous languages, lack of time and opportunities for cultural practices, urbanisation of indigenous people, globalisation and industrialization. These present challenges in the world agriculture calls for immediate attention not only to protect the knowledge base of the communities involved in ethnobotany in active sense but also to revive where it is dormant (Talberth and Susan 2012). Rockstrom *et al.* (2009) have stressed upon the necessity to identify environmental conditions that enable prosperous human development and set limits for the planet to remain in that state. The Holocene epoch provides a reference point, during that period, environmental change occurred naturally and Earth's regulatory capacity maintained the conditions that enabled our ancestors to develop agriculture and modern societies to thrive. Efforts must be taken to understand, preserve and promote traditional agricultural knowledge locked with the indigenous communities encompassing wide wide range of domains of agriculture such as soil types, pests, pathogens, environmental conditions and crop genotypes as well as management domains such as irrigation techniques, soil amendments, planting patterns, pest control, weed control and crop selection to name a few (Brush 2005). Linking multiple domains, such as crop type, soils, and plant diseases, or studying how different domains are linked across regions is a challenging task and generally not attempted by researchers on traditional agricultural systems (Dove 2000). Knowledge on the traditional and sustainable agricultural practices must be strengthened in the interest of the public and the planet, therefore, we suggest a greater role of traditional knowledge experts and the communities holding this knowledge. Greater public participation, more funding and scientific research must be promoted. Sustainable agricultural practices need to be followed which involve the minimal use of chemical fertilizers and pesticides. The sustainable agriculture, climate resilient cultivation practices will further arrest and reverse land degradation caused by rampant use of chemical fertilizers. This would also halt biodiversity loss especially the bees and other pollinator species which are very important for crop diversification (SDG 15).

## 4. HEALTH AND WELLBEING OF THE PEOPLE: BLEND OF TRADITIONAL KNOWLEDGE AND MODERN SCIENCE

Of the various uses of plants, medicinal plants used for human health and well-being are the most diverse (Garnatje, Peñuelas, and Vallès 2017b) because of the presence of specialized metabolites [SM's]. Specialized metabolites with medicinal properties are non-uniformly distributed in certain families of plants and these plants act as natural chemical factories for the production of SM's (Zhu *et al.* 2011). The SM's have promising health promoting effects and are an important source of many of the present day drugs. Medicinal plants play a major role in the primary health care of about 80 percent of the world's population living in developing nations. Not only in the developing countries, but natural products and medications derived from them also contribute significantly to the health care systems of the remaining 20 percent of the population residing in developed countries (Bussmann 2002). Interestingly, of the 25 best-selling pharmaceutical drugs, 12 are natural products derived from the plants [Baker *et al.* 1995, Farnsworth *et al.* 1985]. Ethnobotany have significantly contributed to the discovery of numerous medicines such as artemisinin [from *Artemisia annua*], Aspirin [from *Filipendula ulmaria* [L.] Maxim.], codeine and papaverine [from *Papaver somniferum* L.], colchicine [from *Colchicum autumnale* L.], digoxin and digitoxin [from *Digitalis purpurea* L.], tetrahydrocannabinol and cannabidiol [from *Cannabis sativa*] and many more (Garnatje, Peñuelas, and Vallès 2017b). The importance of Artemisinin discovery was recognized when Tu

Youyou, a chinese scientist was awarded Nobel prize in 2015 (Su and Miller 2015). Further, a search on Google scholar titled “wild plants as medicine” shows 216,000 results [custom range was set 2000-2017].

Indigenous and tribal communities use thousands of plants for medicinal purposes, many of them are not even botanically named and many drugs of the plant origin are waiting to be discovered by modern science. Famous anthropologist David Maybury-Lewis had emphasised the role of tribal communities in assisting the discovery of more and more medicinal plants which are being used by them for their medical practices (Wright 2012). Ethnobotanists can expedite identification process of probable medicinally valuable plants, rather than undertaking random screening, clues and leads can be derived from the ethnobotanical knowledge which can ease the task of bioprospecting of the plants (Saslis-Lagoudakis *et al.* 2012). Garnatje et al. (Garnatje, Peñuelas, and Vallès 2017a,b) suggested a term “ethnobotanical convergence” for the similar use of medicinal plants by different cultures of the world. Although the term “ethnobotanical convergence” was criticised by Hawkins and Teixidor-Toneu (Hawkins and Teixidor-Toneu 2017), nevertheless we believe that it can expedite the process of target based drug discovery. Linking ethnobotany with other disciplines such as phytochemistry, pharmacology, pharmacognosy and molecular biology can aid in identification and screening of important plants for their promising role in treating diseases. Further, approaches such as genomics and omics can also be employed to identify the genes underlying the (specialized) metabolites present in the plants characterized by high throughput metabolomics approaches such as Gas chromatography–mass spectrometry (GCMS), Liquid chromatography–mass spectrometry (LCMS) and Nuclear magnetic resonance spectroscopy (NMR) (Schilmiller, Pichersky, and Last, 2012). Proper identification, utilization and conservation of medicinal plants can assist in providing better alternative healthcare services in rural areas especially in the developing countries. Further a number of wild medicinal and other aromatic plants are highly valuable for example consumers spend more than $6 billion a year on medicines derived from tropical plants (Plotkin 1993). The scarcity of better health care services providing better healthcare services, ensuring healthy lives and promoting well being of the people at all ages (SDG 3) in the developing countries of Asia and Africa underpins the importance of ethnomedicinal plants. Upward trend of dependency on the plant based medicines especially in the past few decades suggest that the role of plant-based drugs will continue to grow in the coming years which may put pressure on the available medicinal plant resources. With the growing burden of diseases coupled with issues such as population growth and climate change, the discovery of plant based medicines needs to hastened using leads from indigenous communities in collaboration of experts from multiple disciplines.

## 5. ENSURING SUSTAINABLE CONSUMPTION-PRODUCTION PATTERNS WOULD HALT BIODIVERSITY LOSS

Harvesting practices of wild plants are generally invasive and are destructive to the naturally occurring wild vegetables and medicinal plants which may pose serious threat to these important plants and if kept unchecked sometimes may lead to extinction of some of the important species. According to the World Wildlife Fund and International Union for Conservation of Nature, about 50,000 to 80,000 species of flowering plants are currently being used for medicinal purposes worldwide and of these, about 15,000 species are threatened with extinction from overharvesting and habitat destruction (Bentley 2010). Harvesting related issues coupled with over-exploitation, over usage and climate change necessitates the need for change in collection and consumption patterns. The collection and consumption patterns need to be congruous with the self-regeneration potential of wild genetic resources, ethnobotanists can act as a bridge between the plants and people in the conservation of plant genetic resources (Cunningham 1992). Various researchers have demonstrated the importance of ethnobotany in the conservation and management of vegetation resources. For example, Phillips and Gentry [Phillips, and Gentry, 1993a,b] have shown that the versatility of uses, as well as the popularity of a plant, may represent a useful measure to indirectly evaluate the harvesting ‘‘pressure’’ to which that species is exposed in nature, as well as the role that a given group of plants plays in local cultural practices. Many other studies have also highlighted the role of ethnobotany in conservation of biodiversity (Bussmann 2002). Ethnobotany could help conserve biodiversity by proposing realistic and functional models for natural resource usage and management that could be used in policy planning and decision making (de Albuquerque et al., 2009). A case study from Southern Ecuador has stressed the need to include interdisciplinary approaches for the conservation of ethnomedicinal plants and prevent from over harvesting. The most popular herbal tea of Southern Ecuador, the “Horchata” which consists of more than 30 medicinal herbs, nowadays, these 30 ingredients are organically produced by local farmers in small managed gardens instead of directly collecting from the wild which poses greater pressure on the wild population (Bussmann 2002). Peters, Alexiades, and Laird (2012) has also suggested the role of imparting skills to the indigenous communities for the better management of the tropical forests. This would reduce the dependency on the external inputs and create a skilled workforce of local communities. Experts from various disciplines such as forestry, ecology, ethnobotany, economics and anthropology can intervene and play a crucial role in managing the forests and other resources. Skills and knowledge of best practices such as how to grow, harvest and consume wild vegetables and other resources in a sustainable manner (SDG 12) would also play a synergistic role in strengthening the community management of the valuable resources.

Awareness programs at larger scale must also be integrated while training selected members of local indigenous communities to highlight negative effects of destructive harvesting practices. The sustainable consumption production patterns would further halt biodiversity loss (SDG15). Besides this conservation initiatives can be undertaken along with the help of conservation scientists, geneticists and the people's participation. Integration of traditional knowledge into ecological research for biodiversity conservation involving local communities holds the potential to become sustainable (Peters 2011) and it must be recognised and promoted (Posey 1992, Pimbert and Pretty, 1995).

## 6. CONCLUSIONS

The role of ethnobotanical knowledge, indigenous communities and ethnobotanists has to be recognised on an urgent basis in realising Sustainable Development Goals. An international collaboration consortium deriving people from various countries and various fields can be established to reap the benefits of traditional ethnobotanical knowledge to alleviate poverty, end hunger, provide better healthcare facilities, combat climate change and conserve biodiversity and solve biodiversity related issues. Digitisation and the creation of universal databases on the usage of plants for various purposes as a global common can be initiated to disseminate the information with regard to ethnobotanically important plants and the knowledge associated with it. The modern scientists can use these clues to further establish scientific reasoning for example which compound may be responsible for treating a particular disease?, what is the nutritional profile of a plant?, whether it can be recommended as a source of nutrition or not and if yes, how much quantity is sufficient? Thus we call for strengthening ethnobotanical studies and sufficient funding needs to be channeled for promoting research in this field in order to meet SDGs. We conclude this with a quote by Dr. Margaret Chan **(**Former Director General of WHO), “The two

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systems of traditional and Western medicine need not clash. Within the context of primary health care, they can blend together in a beneficial harmony, using the best features of each system, and compensating for certain weaknesses in each. This is not something that will happen all by itself. Deliberate policy decisions have to be made. But it can be done successfully"(WHO 2008). This holds true not only for the traditional medicines but also for other domains of traditional knowledge such as food plants, sustainable agriculture, biodiversity conservation and climate change. Traditional knowledge can be supplemented with the modern advancements in science. This integrated approach involving a blend of traditional knowledge and modern advancements in science can contribute to achieve the SDGs if planned and implemented properly. These integrated approaches are in consonance with the SDG 17 (revitalize the global partnership for sustainable development) which emphasizes the importance of global partnership for achieving the rest of the 16 goals. We believe that ethnobotany research groups and societies from various parts of the world must initiate collaborations and partnerships among themselves and with other fields in a cross-disciplinary manner for realising Sustainable Development Goals for the larger interests of the people and planet.

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All data generated or analyzed during this study are included in this publication.

**Authors contribution**

AK wrote the first draft of the manuscript. All authors conducted literature research and contributed to the preparation and critical revision of the manuscript. All authors read and approved the final manuscript.

**Competing Interest**

The authors declare that they have no competing interests.

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