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USING INDIGENOUS KNOWLEGDE IN AGROECOLOGICAL AND CLIMATE CHANGE RESILIENCE PRACTICES

(Sách tham khảo)

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ABBREVIATION

ADC	Agriculture and Forestry Research & Development Center for Mountainous Region
CC	Climate Change
EM	Ethnic Minority
IK	Indigenous Knowledge
PRA	Participatory Rural Assessment
PR	Participatory Research
WIPO	World Intellectual Property Organisation

FOREWORD

Climate change is one of the biggest challenges to the human being in the 21st century. There have been and will be serious impacts caused by climate change to people's production, daily life and the environment all over the world. In Vietnam, the annual average temperature has increased by about 0.5°C while the sea level has risen by approximately 20 cm in the last 50 years. The country is among those most affected by climate change. Climate change impacts vary among differing geographical areas, objectives and livelihood sources. Thus, understanding climate change's direct impacts on the community and working out appropriate response measures could only be done when being based on the community itself and local knowledge.

Indigenous knowledge, or so-called traditional knowledge or local knowledge, is knowledge which is accumulated and developed by people in a community based on their experience that has been validated in reality and regularly changes to adapt to natural, cultural and social environment. Therefore, indigenous knowledge is appreciated as a basis on which decisions are made on local different aspects in daily life such as nature exploitation, cultivation and livestock systems, water source seeking, self-defense and health care; and adaptation to environmental changes. Indigenous knowledge is enriched with the integration of new experience or new knowledge obtained during acculturation. Natural selection over hundreds or thousands of years has helped to form a bank of indigenous knowledge. Indigenous plants or animals have been selectively domesticated and involved in production over generations to provide food, medicines and other products to meet human's needs and cultivation indigenous knowledge has become a treasure of the human.

This book provides methods, steps to identify and use indigenous knowledge in agroecological practices for climate change adaptation as well as several typical agroecological models/practices in the Northern mountain region, and serves as a reference material for non-governmental organizations, civil society organizations, lecturers and students in universities, research institutes, scientists and local governments.

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1.1.1. Indigenous knowledge

Indigenous knowledge definition

According to the World Intellectual Property Organization - WIPO (2012), indigenous knowledge or traditional knowledge is knowledge including know-how, skills and practices that are developed, sustained and passed on from generation to generation within a local or indigenous community. Indigenous knowledge (IK) is, broadly speaking, the knowledge used by local people to make a living in a particular environment (Warren, 1991). Terms used in the field of sustainable development to designate this concept include indigenous technical knowledge, traditional environmental knowledge, rural knowledge, local knowledge and farmer's or pastoralist's knowledge. Indigenous knowledge can be defined as a body of knowledge built up by a group of people through generations of living in close contact with nature (Johnson, 1992). Generally speaking, such knowledge evolves in the local environment, so that it is specifically adapted to the requirements of local people and conditions. It is also creative and experimental, constantly incorporating outside influences and inside innovations to meet new conditions. It is usually a mistake to think of indigenous knowledge as old-fashioned or unchanging.

There are many terms used to describe knowledge of indigenous people and local communities, namely: Traditional Knowledge, Traditional Ecological Knowledge, Indigenous Knowledge, Indigenous Ecological Knowledge, and Local Ecological Knowledge. In this document, we use the term "Indigenous Knowledge" (IK). Accordingly, IK includes both knowledge organized by indigenous people as well as that held by the local community with long lasting, multi-generational tradition and their interaction with the environment.

IK is based on long term, place-based relationship with species and the ecological system. It shows up in many forms, including verbal communication, in writings, songs, dances, arts, rituals and festivals. Not being a static knowledge, IK develops and adapts to changes in the natural environment (Gomez-Baggethun & Reyes-Garcia, 2013). It is diversified and of local nature and might be mixed with other contemporary types of knowledge.

While IK research originally emphasized indigenous technical knowledge of the environment, it is now accepted that the concept of IK goes beyond this narrow interpretation. IK is now considered to be cultural knowledge in its broadest sense, including all of the social, political, economic and spiritual aspects of a local way of life.

Sustainable development researchers, however, have found the following categories of IK to be of particular interest: resource management knowledge and the tools, techniques, practices and rules related to pastoralism, agriculture, agroforestry, water management and the gathering of wild food; classification systems for plants, animals, soils, water and weather; empirical knowledge about flora, fauna and inanimate resources and their practical uses; and the worldview or way the local group perceives its relationship to the natural world (Emery, 1996).

Topics typically covered in IK research

According to Grenier (1998) and Matowanyika (1994), the main topics covered in IK research are:

- Local organization, controls, and enforcement - institutions for resource management; common property management practices;

decision-making processes; conflict management practices; traditional laws, rights, taboos and rituals.

- Social networks - kinship ties and their effect on power relations, economic strategies and allocation of resources.
- Local classification and quantification - a community`s definitions and classification systems for plants, animals, soils, water, air, and weather; and indigenous methods of counting and quantifying.
- Learning systems - indigenous methods of imparting knowledge; indigenous approaches to innovation and experimentation; and indigenous specialists.
- Pastoral systems - herd movement; range evaluation and monitoring; animal breeding and production; traditional fodder and forage species and their specific uses; animal diseases and traditional ethno-veterinary medicine.
- Agriculture - farming and crop systems; indigenous indicators to determine favorable times to prepare, plant, and harvest gardens; land preparation practices; ways to propagate plants; seed storage and processing; crop planting, harvesting and storage practices; food processing and marketing; and pest management systems and plant protection methods.
- Agroforestry - the management of forest plots and trees; the knowledge and use of forest plants and animals; and the interrelationships between trees, crops, herds and soil fertility.
- Water - traditional water-management and water conservation systems; traditional techniques for irrigation; and use of specific species for water conservation.
- Soil - soil conservation practices; the use of specific species for soil conservation; and soil fertility enhancement practices.
- Plants - as a source of wild food, building material, household tools, personal uses (dyes, perfumes, soaps), fuel-wood and charcoal, medicinal purposes.
- Wildlife - animal behavior, habitats, uses.

- Worldview - views of the universe and humanity's place within it, relationship between humans and nature, myths, beliefs, customs.

Characteristics of indigenous knowledge

According to Mai Thanh Son et al (2007), indigenous knowledge has following characteristics:

- Based on experience: IK was formed during the process of experiencing and summarizing into knowledge.
- Regularly verified over decades: Always used in a selective manner in life development.
- Adapt cultural and environmental conditions: Suitable with natural and social conditions of the human communities. Reflect a common feature of culture - convergence (human communities that live in the same natural conditions will share similar cultural characteristics).
- Active and ongoing: IK is not a constant and unchangeable structure but always sees incorporation during its self-development or acculturation.

1.1.2. Importance of indigenous knowledge

Traditional knowledge has now become a highly valuable source of information for archeologists, ecologists, biologists, ethnologists and meteorologists. These pieces of knowledge include plants' medicinal effect and understanding of biodiversity and effects of purposeful burning for management of specific resources. Therefore, indigenous knowledge plays a crucial role in preserving the cultural values of an ethnic group or a nation.

Rehabilitation ability when coping with changes were incorporated in indigenous knowledge and know-how, and reflected in diverse resources and livelihood, social organization and networks, and cultural values and attitude (Nyong *et al.,* 2007; Pareek *et al.,* 2011; Naess, 2013). Erosion of traditional and local knowledge can weaken the local community's adaptation ability in future (Ford and Smit, 2004; Alexander *et al.,* 2011). If local knowledge is well incorporated into adaptation plans, its preservation

and application would strengthen the indigenous communities' capacity in climate change rehabilitation.

Indigenous knowledge also helped to build up social capital which is valuable in securing and increasing livelihood opportunities (Berkes *et al.,* 2000). At the same time, it includes an important component of global knowledge of development issues, contributes strategies to address issues of local communities and especially economic disadvantages (World Bank, 1998). Therefore, scholars in the knowledge-based economy are uncovering these ideas in the hope that indigenous knowledge might carry important messages that could be used to address current shortcomings in sustainable agriculture and environment (Berkes *et al.,* 2000).

Currently, IK is commonly applied in agricultural practices by applying indigenous plants and livestock varieties. Vu Van Liet *et al.* (2011) indicated that the Thai community in the northern mountain region was making use of indigenous varieties, specifically 7 kinds of food plants/crops, 13 kinds of vegetables, 7 kinds of poultry and 9 kinds of cattle. It was appreciated that the northern mountainous communities were managing and utilizing a group of diverse and valuable crops and livestock in view of their high tolerance to the adverse events. These indigenous varieties are an important part of the production system, as people become increasingly resilient to impacts of extreme weather events and climate change. IK is also applied in many farming techniques to be able to adapt to extreme weather events. As farming is concentrated on steep terrains in the mountainous area, many traditional technical measures have been applied to limit soil erosion due to heavy rains. These are, for example, the creation of terraced fields, arranging rock into contour lines, intercropping to cover the ground. Notably, indigenous irrigation and water retention techniques in complex hilly and mountainous terrains have been widely applied in many EM communities such as wheels, water sweep buckets, water pipes made of bamboo, digging wells in the field to keep water and so on. These have helped in avoiding dryness and drought. IK makes the EM community's agriculture practice sustainable over generations.

IK is an underutilized resource in the development process (World Bank, 1998). Thus, scientists in the knowledge-based economy are studying new ideas and innovations in the hope that indigenous knowledge could

contain important messages that could be used to address issues faced by modern agriculture and environment (Berkes *et al.,* 2000). The combination of indigenous knowledge and sciences and techniques will help promote the former's values and address the latter's limitations in resolving agricultural and environmental problems.

Incorporating IK into research projects can contribute to local empowerment and development, increasing self-sufficiency and strengthening self-determination (Thrupp, 1998). Utilizing IK in research projects and management plans gives it legitimacy and credibility in the eyes of both local people and outside scientists, increasing cultural pride and thus motivation to solve local problems with local ingenuity and resources. Local capacity-building is a crucial aspect of sustainable development, and researchers and development specialists should design approaches which support and strengthen appropriate indigenous knowledge and institutions. Indigenous people can provide valuable input about the local environment and how to effectively manage the natural resources. Outside interest in indigenous knowledge systems has been fueled by the recent worldwide ecological crisis and the realization that its causes lie partly in the overexploitation of natural resources based on inappropriate attitudes and technologies. Scientists now recognize that indigenous people have managed the environments in which they have lived for generations, often without significantly damaging local ecologies (Emery, 1996). Many feels that indigenous knowledge can thus provide a powerful basis from which alternative ways of managing resources can be developed. IK technologies and know-how have an advantage over introduced forms in that they rely on locally available skills and materials and are thus often more cost-effective than introducing exotic technologies from outside sources. As well, local people are familiar with them and so do not need any specialized training.

1.1.3. Limitations of Indigenous Knowledge

All knowledge systems have their own limitations and weaknesses, and IK is not an exception. Both IK and scientific knowledge might be neither suitable nor accurate in some circumstances. IK is sometimes accepted uncritically because of naive notions that whatever indigenous people do is naturally in harmony with the environment. There is historical and

contemporary evidence that indigenous peoples have also committed environmental 'sins' through over-grazing, over-hunting, or over-cultivation of the land. It is misleading to think of IK as always being 'good,' 'right' or 'sustainable'. A critical assumption of indigenous knowledge approaches, for example, is that local people have a good understanding of the natural resource base because they have lived in the same, or similar, environment for many generations, and have accumulated and passed on knowledge of the natural conditions, soils, vegetation, food and medicinal plants etc. However, under conditions where the local people are in fact recent migrants from an entirely distinct ecological region, they may not have much experience with their new setting yet. In these situations, some indigenous knowledge of the people may be helpful, or it may cause problems (e.g., use of agricultural systems adapted to other ecological areas). Therefore it is important, especially when dealing with recent migrants, to evaluate the relevance of different kinds of indigenous knowledge to local conditions.

Wider financial and social forces can also erode indigenous knowledge. Pressure on indigenous peoples to integrate with larger societies is often great, the social structures which generate indigenous knowledge and practices can break down as they become more integrated. The growth of domestic and global markets, the imposition of educational and religious systems and the effect of various development processes are leading more and more to the 'homogenization' of the world's cultures (Grenier, 1998). Indigenous beliefs, values, customs, know-how and practices may therefore be changed and the resulting knowledge base may become incomplete.

Sometimes IK that was once well-adapted and effective for securing a livelihood in a particular environment becomes inappropriate under conditions of environmental degradation (Thrupp, 1989). Although IK systems have a certain amount of flexibility in adapting to ecological change, when change is particularly rapid or drastic, the knowledge related with them may be inappropriate and possibly damaging in the changed circumstances (Grenier, 1998).

1.1.4. Loss of indigenous knowledge

IK can generally adapt to gradual changes in natural and social environment as indigenous customs are closely integrated in cultural values passed on

from generation to generation. However, a lot of IK systems are facing risk of being gone due to the rapid changes in the natural environment as well as global economic, political and cultural changes. The practices might disappear as they become unsuitable to new challenges or due to their too slow adaptation. Furthermore, lots of local practices might also be gone due to the invasion of foreign technologies or development concepts which promise short term benefits or solutions to issues without possibility to maintain them. Accordingly, it is necessary to stay alerted not to degrade effective indigenous practices. For examples, the introduction of market-oriented agroforestry practices which focus on sole cropping relates to the loss of IK, via losses of biodiversity and cultural diversity. Or the policies promoting hybrid maize and rice varieties devalue local adaptive ones.

The loss of many indigenous customs might cause adverse impacts mainly on those people who developed and earned their living based on them. Better awareness of the important role that IK might play in the development process can help preserve valuable skills, technologies, artifacts and problem-solving strategies in the local community. Normally, such local practices also have impacts on the global concerns. Therefore, the preservation of IK might enrich the global community and contribute to promoting cultural development. In a number of cases, it can also help protect the global environment.

With the rapid environmental, social, economic and political changes occurring in many areas where indigenous people live, there is a danger that the IK they possess will be overwhelmed and forever lost. As a consequence of exposure to worldwide and domestic influences, younger generations acquire distinct values and lifestyles, and traditional communication networks are breaking down, meaning that Elders are dying without passing on their knowledge to children. In some cases, the actual existence of indigenous people themselves is threatened. Researchers can assist in preserving IK through the following:

- Record and use IK: document IK so that both the scientific and local community have access to it and can apply it in the formulation of sustainable development plans.

- Raise awareness in the community about the value of IK: record and share IK success stories in songs, plays, story-telling, videos and other traditional or modern means of communication. Encourage people to take pride in their knowledge.
- Help communities record and document their local practices: Get local people involved in recording their IK by training them as researchers and providing means of documentation (computers, video equipment, etc.).
- Make IK available: disseminate IK back to the community through newsletters, videos, books and other media.
- Observe intellectual property rights: have agreements so that IK is not misused and benefits return to the community from which it originates.

Threats to Indigenous Knowledge

The preservation of Indigenous traditional knowledge is under threat. The following threats to indigenous traditional knowledge were recognized in a report by the Australian Institute of Aboriginal and Torres Strait Islander Studies to the Convention on Biological Diversity Secretariat (Kelly, 2005):

- Political pressures - The recognition and standing if indigenous people, traditional knowledge, including involvement in policy and legislative development.
- Social and economic pressures - Assimilation, poverty, education, marginalization of women, loss of language.
- Territorial pressures - Deforestation, forced displacement and migration.
- Exploitation of traditional knowledge - bio-prospecting (seeking fauna and flora species that might be used to manufacture medicine and other compounds of commercial value).
- Development policy - Agricultural and industrial development.
- Globalization and trade liberalization.

- Lack of protection policy and strategy at national level intensifies threats to existence and development of IK.
- Climate change degrades the ecosystem and increases the risk of vanishing of indigenous creatures.

It can be seen that despite some limitations, IK still plays a crucial role in the local communities' life and production activities, and is appreciated as basis on which decisions are made on local different aspects in daily life such as nature exploitation, cultivation and livestock systems, water source seeking, self-defense and health care; and adaptation to environmental changes. IK preservation and development depend on the identification and use of IK in daily life and production, especially in the context of climate change.

1.2. Agroecology

1.2.1. Concept

Agroecology is a broad term which is understood in various ways depending on the background and experience of differing audiences. Agroecology is a science that applies, adapts to ecological terms and principles to design and manage sustainable agriculture systems and provide a frame for monitoring efficiency of agriculture systems (Altieri, 2002).

According to the Agroecology Learning alliance in South East Asia (ALiSEA), the agroecological approach might offer solutions to agricultural challenges in Mekong Region. Agroecoglogy enables production of various foods at high quality, protects the environment by avoiding causing pollution which affects human health, and mitigates global warming. There is an interrelationship among agroecology, indigenous knowledge and climate change.

Miguel Altieri (2005) indicated five historical principles to define agroecology as following:

1. Enhance recycling of biomass and optimizing nutrient availability and balancing nutrient flow.

2. Securing favorable soil conditions for plant growth, particularly by managing organicmatter and enhancing soil biotic activity.

3. Minimizing losses due to flows of solar radiation, air and water by way of micro-climate management, water harvesting and soil management through increased soil cover.

4. Species and genetic diversification of the agroecosystem in time and space.

5. Enhance beneficial biological interactions and synergisms among agro-biodiversity components thus resulting in the promotion of key ecological processes and services.

Though agroecology initially dealt primarily with crop production and protection aspects, in recent decades, new dimensions such as environmental, social, economic, ethical and development issues are becoming relevant. Today, the term 'agroecology' means either a scientific discipline, agricultural practice, or political or social movement (Wezel *et al.,* 2009).

Additional principles developed for agroecology scaling-up

People might mention issues relevant to connecting the two most important elements in a food system - consumers and producers - via the development of alternative food network based on rehabilitation capacity, participation, locality, equity and justice (Gliessman, 2015). Agroecology might also involve issues such as agroecological diversity, agronomic conversion and participation of the whole society (Stassart *et al.,* 2012). Four among these principles might be listed as below (Stassart *et al.,* 2012):

1. Appreciate the agro-biodiversity as the point of entry for the re-design of agriculture and food systems ensuring food sovereignty and the autonomy of farmers.

2. Diversify knowledge (traditional/local know-how and practices, education and technical knowledge) in definitions of research topics, definitions of those involved and in seeking solutions.

3. Work on agriculture systems from the viewpoint of promoting long-term agronomic conversion process, emphasizing nature of adaptation and recovery ability.

4. Promote participatory researches driven by the needs of the society and learners while still ensuring scientific coherence.

Six agroecological initiatives

According to the Agroecology Learning Alliance in South East Asia (ALiSEA, 2018), there are six agroecological initiatives implemented and applied in Southeast Asian countries such as Vietnam, Lao PDR and Cambodia.

(1) Agroforestry - AF

Agroforestry is a collective name for land-use systems and technologies where woody perennials (trees, shrubs, palms, bamboos, etc.) are deliberately used on the same land-management units as agricultural crops and/or animals, in some form of spatial arrangement or temporal sequence. Agro-forestry is a dynamic, ecologically-based, natural resource management practice that, through the integration of trees on farmland in the agricultural landscape, diversifies and sustains production for increased social, economic and environmental benefits.

(2) Conservation Agriculture - CA

Conservation Agriculture (CA) is an agro-ecosystems management approach aimed at improving and sustaining agricultural productivity, increasing profits and food security while preserving and enhancing the resource base and the environment. Accordingly, conservation agriculture promotes the cultivation system that maintains permanent soil cover, minimizes soil disturbance (i.e. no land preparation), and diversifies flora species.

(3) Integrated Pest Management - IPM/Integrated Crop Management - ICM

Integrated agriculture provides high-quality food and other products by using natural resources and regulating mechanisms rather than polluting chemical inputs to secure sustainable farming. The agronomic techniques and biological/physical/chemical methods are carefully selected and balanced taking into account the health of people (i.e. farmers and consumers) and of the environment.

(4) Integrated Farming - VAC

Integrated farming addresses integrated farming approaches that have been promoted as alternatives to Green Revolution agriculture since

the 1990s for self-sufficient farming. The New Theory farming system in Thailand and the VAC system in Vietnam (VAC in Vietnamese is Vuon, Ao, Chuong which means "garden/pond/livestock pen") consist in highly bio-intensive methods of small-scale farming in which food gardening, fish rearing and animal husbandry are integrated. These intensive farming practices, which integrate food and energy systems, make optimal use of land, water and solar energy in order to achieve high economic efficiency with low capital investments.

(5) Organic Agriculture - OA

Organic agriculture aims at sustaining the health of soils, ecosystems and people. It relies on ecological processes, biodiversity and natural cycles adapted to local conditions, rather than the use of chemical inputs with potentially adverse effects. Organic agriculture combines tradition, innovation and science to benefit the shared environment and promote fair relationships and a good quality of life for all involved.

(6) System of Rice Intensification - SRI

The System of Rice Intensification, known as SRI is an agro-ecological approach for increasing rice productivity (and more recently other crops) by changing the management of plants, soil, water and nutrients.

1.2.2. 10 Elements of Agroecology

Food and Agriculture Organization (FAO, 2018) identified 10 elements of agroecology, including:

Diversity

Diversification is key to agroecological transitions to ensure food security and nutrition while conserving, protecting and enhancing natural resources.

Co-creation and sharing of knowledge

Agricultural innovations respond better to local challenges when they are co-created through participatory processes.

Synergies

Building synergies enhances key functions across food systems, supporting production and multiple ecosystem services.

Efficiency

Innovative agroecological practices produce more using less external resources.

Recycling

More recycling means agricultural production with lower economic and environmental costs.

Resilience

Enhanced resilience of people, communities and ecosystems is key to sustainable food and agricultural systems.

Human and social values

Protecting and improving rural livelihoods, equity and social well-being is essential for sustainable food and agricultural systems.

Culture and food tradition

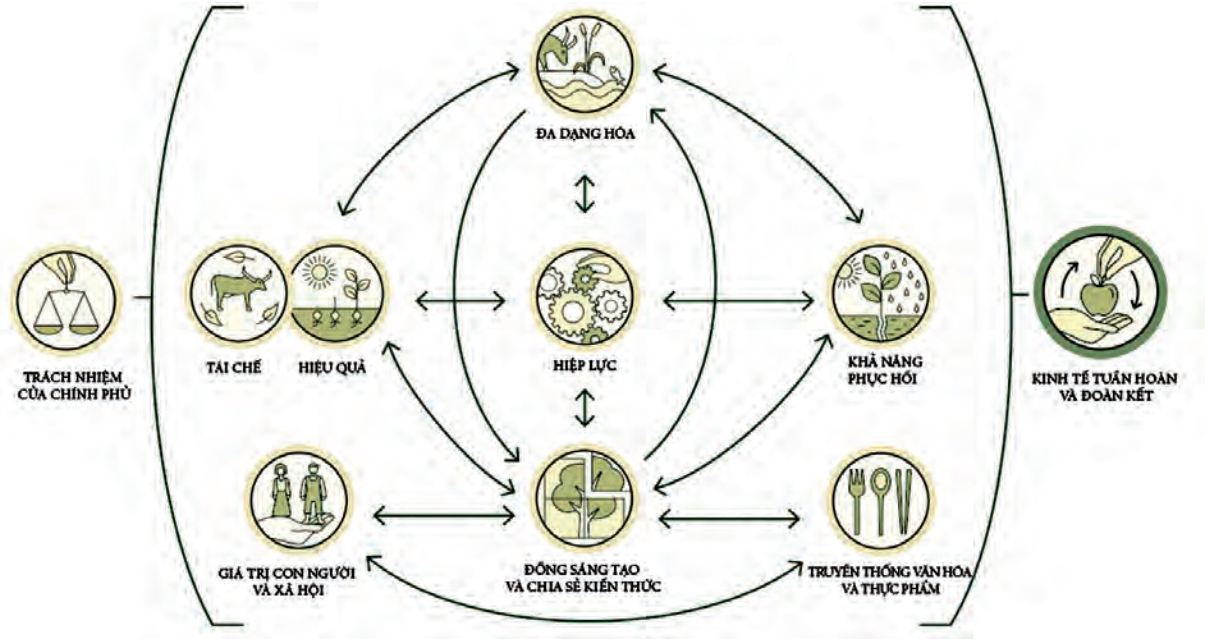
By supporting healthy, diversified and culturally appropriate diets, agroecology contributes to food security and nutrition while maintaining the health of ecosystems.

Responsible governance

Sustainable food and agriculture require responsible and effective governance mechanisms at different scales - from local to national to global.

Circular and solidarity economy

Circular and solidarity economies that reconnect producers and consumers provide innovative solutions for living within our planetary boundaries while ensuring the social foundation for inclusive and sustainable development..



10 elements of agroecology (FAO, 2018)

1.3. Climate Change and impacts of Climate Change

1.3.1. Concepts related to Climate Change

Climate change

A change in the state of the climate that can be identified by changes in the mean and the variability of its properties and that persists for an extended period, typically decades or longer. Climate change may be due to natural internal processes in climate scheme, or external forcings or regular impacts caused by people, which cause changes in the composition of the atmosphere or in land use (IPCC, 2014).

Mitigation

Mitigation is an intervention to reduce the emissions sources or enhance the sinks of greenhouse gases (IPCC, 2014).

Adaptation

Adaptation is an adjustment in natural or human systems in response to actual or expected climatic stimuli or their effects, which moderates harm or exploits beneficial opportunities (IPCC, 2014).

Community based adaptation/CBA

Community based adaptation (CBA) to climate change is an approach to adaptation that aims to include vulnerable people in the design and implementation of adaptation measures.

Community based adaptation to climate change is often based on two complementing forms of analysis. The first involves incorporation of participatory approaches into development to understand how people are faced climate risks and vulnerability. The second form calls interaction between development practitioners and/or climate scientists to seek to incorporate local demands into future forecasts of climate change (Forsyth, 2017). In CBA, indigenous knowledge plays such a crucial role and is regarded as a resource for effective adaptation to climate change.

Resilience

Resilience is the capacity of social, economic and environmental systems to cope with a hazardous event or trend or disturbance, responding or reorganizing in ways that maintain their essential function, identity and structure, while also maintaining the capacity for adaptation, learning and transformation (IPCC, 2014). Thus, resilience is the ability of a system to absorb, withstand and bounce back after an adverse event.

Vulnerability

Vulnerability to climate change is the degree to which geophysical, biological and socio-economic systems are susceptible to, and unable to cope with, adverse impacts of climate change. Vulnerability is determined by sensitivity, exposure and adaptive capacity (IPCC, 2014).

1.3.2. Climate change in Vietnam

Vietnam is considered as one of the most vulnerable countries to climate change. Its vulnerability can be assessed from the loss of life and asset damages generated by natural disasters every year as well as the national GDP loss.

Temperature

The temperature measured at most of the monitoring stations in Vietnam is on the rise with significant increase level in recent decades. At national level, the average temperature increased about 0.62°C in 1958 - 2014, of which the increase of 0.42°C was made in 1985 - 2014 period. The average growth rate is about 0.10°C each decade which is lower than the global average figure of 0.12°C/decade (IPCC, 2013). The temperatures measured at the coastal and island monitoring stations increase at lower rate than that of inland stations. Temperature increase varies between regions and seasons with the highest jump in winters and in the Central Highland, lowest level in springs and in the South Central region.

Precipitation

In the 1958 - 2014 period, the average precipitation of the country slightly increased with the highest level in springs and winters and decreased in autumns. In general, the annual precipitation tended to reduce in the Northern region (reduced by 5.8% ÷ 12.5% over the monitoring period of 57 years) while it is apt to increase in the Southern region (6.9% ÷ 19.8% over the same period). It made the highest increase in the South Central region (19.8%/57 years) and the biggest reduction in the Northern Delta region (12.5%/57 years). In the Northern region, the precipitation significantly decreases in autumn time and slightly increases in spring time. The seasonal precipitation in all Southern climate regions of Vietnam tends to increase with the highest level in winter time (35.5% ÷ 80.5%/57 years) and spring time (9.2% ÷ 37.6%/57 years).

The 35°C high temperature-related extreme weather events occur more frequently in most of the country's regions, particularly in the Northeast, Northern Delta and Central Highland regions with 2÷3 extended days/10 years. The adverse trend is recognized at monitoring stations located in the Northwest, Southern Central and Southern regions. Records of highest temperature and biggest leap of average temperature are continuously broken year by year. For example, the highest temperature monitored

during heat weaves at Con Cuong station (Nghe An province) was 42°C in 1980, 42.2°C in 2010 and 42.7°C in 2015.

The number of droughts, particularly severe droughts increases across the country. Records are continuously made in the last few years. Severe droughts were observed almost every year since 2000. In 2010, the water flows in the country's river and stream system was 60 ÷ 90% less than the normal average level; the water level was very low in certain areas then. This phenomenon might take place at 40 ÷ 100 year return period. The 2015 rainy season completed early led to the significant shortage of total rainfall against the average level across the nation, particularly in the Southern, South Central and Central Highland regions.

The number of extreme and damaging cold days in the Northern region tends to reduce, particularly in the last two decades. However remarkable changes are noticed year by year with record-breaking duration of extreme cold days as well as damaging temperatures. In 2008, the extreme and damaging cold lasted for 38 days in the Northern region from 13 January to 20 February; ice and snow covered Mau Son mountain (Lang Son province) and Hoang Lien Son mountain (Lao Cai) where the temperatures plunged to -2°C and -3°C. Extreme and damaging cold took place in the Northern region in 2015 - 2016 winter. Though its duration was not long, it established the record-breaking temperature over the last 40 years. The lowest temperatures in high mountainous areas such as Pha Din, Sa Pa or Mau Son were recorded at -5°C to -4°C, ice and snow was observed in various locations, snowy rains took place in Ba Vi (Hanoi) and Ky Son (Nghe An province) for the first time ever.

Rainfall-induced extreme weather events

Extreme rains tend to vary between different climate regions: reduce in most of the station areas in the Northwest, Northeast, Northern Delta and increase in most of the station areas in other climate regions. Monitoring data highlights that off-season and abnormal torrential rains are taking place more often. In recent years, heavy rains occur with special features in duration, locations, frequency and intensity. For example, a record-breaking rain took place in 2008 in Hanoi and its adjacent areas with the rainfall monitored at Hanoi station from 19 PM 30 October 2018 to 01 AM

1 November 2008 at 408mm. The total rainfall of the 10-day heavy rain which covered the provinces from Nghe An to Quang Binh in October 2010 ranged from 700÷1600mm, accounting for more than 50% of the annual precipitation. The torrential rain late July - early August 2015 in Quang Ninh province established a record on the rainfall intensity over a small area. In this rain which extended from 23 July to 04 August 2015, the monitored total rainfall ranged from 1,000 to 1,300 mm and nearly 1,600mm in Cua Ong. Heavy rains do not only happen in rainy seasons but also in dry seasons. The precipitation of off-season rain which lasted from 24 to 27 March 2015 and covered the area from Thua Thien - Hue to Quang Ngai provinces reached 200 ÷ 500 mm.

Sea level rise

On average, the water level measured at marine monitoring stations of Vietnam significantly increases at the rate of about 2.45mm/year. The sea levels measured by marine monitoring stations slightly increased over the period of 1993 - 2014 at the average rate of approximately 3.34mm/year.

Source: Ministry of Natural Resource and Environment, 2016.

1.3.3. Climate change impacts

The global climate change brings about frequent and severe natural disasters which negatively affect the economy, society, culture and environment. Vietnam is one of the countries that are most severely hit by climate change (Dasgupta and all, 2007). The unexpected variations of temperature, precipitation and human activities might negatively impact the human health (ie. increased diseases), increased natural disasters as well as food production due to the seasonal structure changes (McSweeney *et al.*, 2010). By 2020, the three climate change scenarios at low, medium and high levels of Vietnam project that the average annual temperature of the Northern region will increase by approximately 0.5% against the temperature of 1980 - 1999 period while the annual precipitation will increase about 1.4 - 1.8% in the Northern region and 0.3 - 0.7% in the Southern climate regions (FAO, 2011). The sea level rise will take away a vast low land area - wetland ecosystems of the nation's largest deltas which is home of long historical residing communities, origins of wet-rice

civilization, areas of potential for largest agricultural production and natural living areas of various indigenous species including national parks, natural protected areas and biosphere reserves. Researches on the Southeast Asian indicate that climate change can deprive Vietnam of its agriculture productivity by 2 - 15% in the 2080s (Zhai and Zhuang, 2009). Specifically, the intense and frequent floods and droughts will shrink the country's level of bio-diversification of agricultural, industrial and forest species, put many indigenous plants and animals at the risk of extinction and generate severe damages to the country's economy.

The mountainous areas are also considered among the most impacted by climate change. Physical elements of the Northern mountainous areas such as climate, soil, water, topography, biological features, flora and fauna are being impacted by the abnormal fluctuates of temperatures, seasonal changes and torrential rains. The region's population of about 6.5 million people are living in the quickly changing environment which is mainly due to the recent and rapid changes of climate (CARE Vietnam, 2010). The ethnic minorities residing in the Northern mountainous areas have limited opportunities to access to social and educational services (CARE Vietnam, 2013). This leads to the inadequate awareness on climate change of many ethnic minority communities which requires greater efforts in developing capacity building activities to raise their climate adaptation ability.

Climate change is one of the most crucial challenges to the sustainable development of the Northern mountainous area. Climate change takes place in the Northern mountainous area with different forms from its presence in the Central, Central Highland and Southwest regions. Most of the local residents are ethnic minorities and rely on agricultural production income; moreover, the Northern mountainous region is assessed as the country's poorest area. A study conducted in 2010 shows the poverty rates of Bac Kan, Phu Tho and Yen Bai provinces were 32.1%, 19.2% and 26.5%, respectively. Therefore, this area suffers greater damages from extreme climate events than other areas (Climate Change Working Group, 2011). Vietnam has been implementing various climate change adaptation measures with various approaches; of which the community-based climate change adaptation which puts the community at the center and focuses on their priorities, needs, knowledge and abilities to empower

their involvement in the formulation of climate change response plans is the most suitable, sustainable and resource-requiring method.

Projections of potential climate change impacts on agriculture-forestry activities

a. Impacts on agriculture and food security

Climate change affects plant growth and productivity, cultivation period and sharpens the risk of agricultural pests. Climate change impacts the growth and production of livestock as well as increases their illness and disease transmission risks. There is a great demand for plant and livestock development in agriculture to mitigate the risks generated by climate change and extreme weather events.

Due to the higher temperature in the country, the adaptation duration of tropical plant extends; it is adverse for the sub-tropical species. The locations of tropical plants move forward to the higher mountainous and northern areas. The tropical plant adaptation also moves forward to the higher mountainous and northern areas while that of sub-tropical plants shrinks.

In 2070s, the mountainous sub-tropical plants will only grow in areas of 100 - 500m above the sea level and will retreat to the north 100 - 200km from their current locations.

Climate change can exaggerate the frequency, intensity, variations and extremity of dangerous weather events such as storms, hurricanes, tornados, temperature- and seasonal-related natural disasters such as dry and hot weather, floods, inundation or droughts, damaging colds, saline intrusion, agricultural pests that reduce the productivity and yield of the plants and livestock.

Climate change brings about the risk of agricultural land shrink. A significant agricultural land lying on the low terrain of coastal deltas, Red River delta, Mekong Delta will suffer from saline intrusion unless proper adaptations are applied.

b. Impacts on forestry

- Sea level rise will reduce the current mangrove forest areas and cause negative impacts to the cajuput forests and forests planted on acidic soil in the Southern provinces.

- The boundary between primeval and second-growth forests might change. Dipterocarp forests expand to the north and areas of higher elevation; deciduous forests with drought-tolerant plants boom.
- The high temperature in combination with abundant sunlight promotes the photosynthesis and supports the plant assimilation. However, the biomass growth index of the forest might decrease due to the reduced humidity.
- The flora and fauna extinction risk is are strengthened, certain important species such as agarwood, Bhutan cypress, Fujian cypress, redwood, Chukrasia tabularis, Sindora tonkinensis might be extinct.
- The high temperature and increased drought exaggerate the risks of forest fires, diseases and agricultural pests.

c. Impacts on aqua-culture

The sea level rise and increased saline intrusion will lead to the following consequences:

- Intrusion of saline water into inland areas which destroy the living environment of certain fresh-water species.
- Shrinking of the current mangrove forest areas which affect the ecology of certain species.
- Reduced ability to concentrate organic compounds of seaweed ecology which leads to the reduction of photosynthesis product and nutrition provision to zoobenthos. This results in the degraded living environments of various species.

The higher temperature will lead to the following consequences:

- Significant temperature zoning in the standing water bodies and impacts on daily activities of species.
- Some species will move to the northern areas or to deeper layers which change the structure of aquatic animals living in different depth.
- Quicker photochemical and decomposition processes of organic compounds which affect the feed of species. More energy spending on respiration and other activities by aquatic species which leads to the reduction of aqua-cultural productivity and quality.

- Coral reef degradation and destroy, changes in the biophysical, biochemical processes in relation to the inter-relationship between coral and algae.
- The torrential intensity and precipitation reduce the salinity in long time which causes massive death of brackish and coastal species since they do not afford the salinity changes (particularly bivalve animals such as clams, oysters, scallops).

Climate change causes the following impacts on fishing and aquaculture:

- Sea level rise degrades the hydro-physical, hydro-chemical and hydro-biological environments. It leads to the changes in structure, composition and reduced quantity of the current communities.
- Higher temperature disperses the aqua-cultural species. The quantity of sub-tropical fishes of high economic prices reduces or disappears, most of the coral reefs will be destroyed.

(Source: Nguyen Van Thang *et al.,* 2010).

1.4. Relevance of IK to climate change and rehabilitation capacity

IK records the interaction of human activities in natural landscapes over thousands of years. In recent decades, scientists, policy-makers and technical agencies have been aware of the importance and values of IK in developing and enforcing policies relevant to indigenous people, especially CC policies. Researches on IK have helped to fill the persistent gaps of data and information in the community, which can help scientists develop a database of information or changes in the ecosystem or species population (Huffman, 2013; Mason *et al.,* 2012). In the context where climate change becomes more complex, scientists are now more concerned about indigenous and non-indigenous land management to incorporate IK as a part in CC response initiatives (Parrotta and Agnoletti, 2012).

IPCC (AR4, 2007) emphasizes that "indigenous knowledge is an extremely crucial and meaningful basis for the development of response strategies and natural resource management in order to adapt to environmental changes, climate change and other forms". Indigenous or traditional knowledge proves useful in recognizing potentials of some adaptation

strategies as well as the efficiency of cost, participation and sustainable development of the community in the context of climate change impacts.

Furthermore, indigenous knowledge is particularly meaningful in the observation and explanation of climate events. IK has its own depth in time, which may be marginalized or new to scientists. It is meaningful to local livelihood, security and happiness, which makes it vital to adaptation. Indigenous people's observations offer a great contribution to promoting climatology by ensuring that evaluation on climate change impacts and policies on adaptation is recognized and possible to be applied at local level. Indigenous reactions to climate change often relate to changes in livelihood practices and other socio-economic adjustments. Strategies such as joining many livelihood activities and maintaining the diversity of crop varieties and animals secure the safety and mitigate risks in the extreme weather that sees constant changes. Access to resources and based on different land use methods also contribute to their capacity to manage climate change at the local level.

Furthermore, IK also proves its role and meaning in strengthening rehabilitation capacity in coping with changes when it is incorporated into indigenous knowledge and know-how, diverse resources and livelihood. Thus, policies on climate change should support and strengthen the indigenous people's rehabilitation capacity based on the community's indigenous potentials. It is unfortunate that, however, many policies of the governments have limited or narrowed down options, and therefore limited and weakened the indigenous people's efforts. This is reflected in counterproductive policies, including those that resulted in the replacement of traditional livelihood, poor cultivation or reduced diversity of crops, animals, of livelihood, destruction of natural ecosystem and indigenous knowledge erosion. This has been reflected in IPCC previous reports. Due to lack of IK information as most of the traditional knowledge exists in verbal form, IK was beyond the framework of IPCC processes.

Indigenous people are vulnerable to climate change impacts, partly due to their close relation with the local fauna and flora systems (Maldonado, Pandya and Colombia, eds. 2013; Abate and Kronk, 2013; Grossman and Parker, 2012; Parrotta and Agnoletti, 2012). Facing such vulnerabilities, many indigenous people are preparing themselves for climate change impacts by conducting climate change impact assessments and developing indigenous adaptation plans. Incorporating IK as a part of these initiatives

is vital to many indigenous people, as IK serves as the basis for indigenous people to acquire adaptation management capacity. Using IK also ensures that indigenous adaptation and mitigation would be culturally suitable and able to resolve related issues.

Incorporating IK in climate change response initiatives could strengthen the capability to apply these initiatives by making them culturally suitable and by applying indigenous people's knowledge to develop effective adaptation strategies. IK can serve to determine environmental baseline earlier; understand level and impacts of changes in ecological processes; help identify impacts that need mitigating; provide observation evidence to model forecasts or help model realities; offer technologies for adaptation; and identify culturally suitable values to be prevented from direct impacts or impacts caused by adaptation measures (Reidlinger and Berkes, 2001; Williams and Hardison, 2013).

Another important contribution of IK to climate change adaptation relates its comprehensiveness when climate change is incorporated into a variety of socio-economic, cultural and ecological issues. Western sciences have recently recognized importance of comprehensive multidisciplinary viewpoints. IK can serve as a model for researching incorporation of climate change. On the other hand, indigenous people spend more time (as normally on larger areas) on the in-land or the ocean than Westerner scientists, and thus, can be located to conduct and explain observations (especially rare events or species) rather than those less familiar with the regions (Cochran *et al.,* 2013). IK and scientific knowledge can be combined to develop active, diverse climate change strategies which based on various ways to grasp and assess the impacts. Indigenous people can benefit from incorporation of IK into CC adaptation initiatives. Such incorporation in a suitable manner can also ensure that adverse impacts caused by climate change and adaptation measures or strategies are avoidable.

Vietnam is home to 54 ethnic groups who have a long history and their own unique traditional cultures, especially IK in terms of agricultural practices. However, lots of IK has fallen into oblivion when older generations are gone while some of them are still being used and developed. IK is a knowledge system consisting of knowledge about climate, soil, primitive varieties, cultivation techniques, irrigation and water management, plant protection, harvesting and preservation methods.

Particularly, the diversity of crops and animals in the IK system has helped to improve and maintain ecosystem services, strengthen the capacity of CC adaptation, ease vulnerability of the community. Indigenous crops/animals are often of high resilience, less affected by diseases than new ones and do not require investment in intensive farming, which are suitable with many people, including the poor. In addition, using IK in agriculture is one of measures to save costs and prevent loss of disease-resistant flora hereditary materials. Modern technologies, though to some extents, having resolved issues related to the demand for food and fiber, are very costly in term of technology transfer (Davis and Ebbe, 1993).

On the other hand, IK serves as the basis for local people's self-sufficiency and self-determination, helping them less dependent on external environment and therefore less vulnerable to impacts caused by climate change (drought, flood). Furthermore, given their familiarity to indigenous techniques, the local people can understand, apply, maintain and flexibly adjust such techniques better than newly introduced techniques and the community's voice is recognized more effectively.

IK and related activities have become more valuable when the communities are making efforts to strengthen their capacity to adapt to future potential impacts caused by climate change. IK offers additional solutions and options during CC adaptation process. Therefore, the local people have more options when making decisions on what are suitable solutions and models for CC adaptation rather than depending on external factors (new varieties, techniques) (ADC, 2013). Given its nature of evolution and relation with local context, IK helps to build the capacity of households as well as the whole community to adapt to changing situations, including climate changes and natural disasters. Also IK contributes to developing social capital which is valuable in securing and strengthening livelihood opportunities (Berkes and associates, 2000). At the same time, IK serves as an important part in the global knowledge of development issues, offers strategies to resolve the local communities' issues, especially for the poor (World Bank, 1998).

Chapter II: METHODOLOGY AND TOOLS

2.1. Research Methodology and Tools

2.1.1. Matters to be noted in conducting IK research

IK research is the work of complexity that requires ethical matters and methods to be considered when preparing a fair and effective approach to work with local communities.

Conducting IK research should observe the four principles below:

- Appropriate attitude – IK researchers need to be self-critical and must recognize their own bias toward formal scientific, high-tech knowledge. In addition, it is the responsibility of the IK researcher to remember that IK systems may be just as valid or useful or that a low-tech solution can be highly appropriate.
- Appropriate methods – The researcher must ensure that the research methods are tailored to people, cultures, abilities, and requirements and effectively represent local people's points of view.
- Multiple methods – IK research requires a mixture of techniques that together facilitate the collection of different types of data and help confirm or reject research findings through a process of crosschecking or triangulation. A good combination of methods can access knowledge concealed in cultural norms or political factors.
- Broad participation – Participation means involving women, men, and children, disabled of all classes and requires from both researcher and the informants more than mere attendance or answering questions. One way to elicit the IK of a community is by participating in its work and leisure activities (Wickham 1993).

2.1.1.1. Local People's Participation

Participatory research (PR) represents a family of methodological approaches increasingly accepted and utilized by sustainable development researchers and specialists working with indigenous knowledge. PR seeks to involve indigenous people in every step of the research process, as active creators of information and knowledge (Narayan, 1996). It is characterized by a cyclical, ongoing process of research, reflection and action in which local people participate in planning the project, gathering information, analyzing data and taking action. The end objective of participatory research is always practical: to solve local problems.

So as to make the community be more accountable in resource management, engaging members of the community to participate in the research process is vital. There are a variety of ways in which local people can participate in projects, depending on the particular context of the research and the capacity of those involved. Participation can range from consultation or information sharing, where local people are kept informed of research activities but do not influence the research process while the researcher acts only in a guidance capacity and local people take the initiative in project design and implementation.

Participatory Rural Appraisal - PRA

According to Chambers (1994), Participatory Rural Appraisal (PRA) represents a body of qualitative methods which emphasize the use of indigenous or local knowledge and which can be adapted to virtually any research situation. PRA is carried out by a multidisciplinary team consisting of a leader and a few core members, who act as facilitators to assist local people to elicit and record their own knowledge using techniques which involve interference or participation. In a number of cases, local people themselves have been trained as facilitators, a situation is considered to be optimal, which not only contributes to capacity building but solves many of the associated problems such as translation, cultural bias and lack of rapport. People who are literate, speak the local as well as indigenous language and have good standing in the community are said to make very effective field workers. However, PRA supporters stress the importance of choosing the right individuals, and this is best done by consulting with local leaders to get their suggestions for suitable choices.

General Guidelines for Participatory Research

There is, of course, no right or wrong form of local participation. Approaches will vary based on the particular context of the research. However, researchers should, at the very least, consider the following principles in order to ensure that indigenous people are treated as equal partners in a project or program.

• Consultation: there should be full consultation with all affected communities, to plan the research, set the agenda, hear concerns of local people and incorporate suggestions into the research.

• Full disclosure: communities should be told the purpose of the research, sponsors of the research, potential benefits and possible problems associated with the research for both people and the environment, research methodology, and the expected amount of local participation.

• Informed consent: consent must be given by the rural community, after the particulars have been fully disclosed in a manner which is easily understood by community members (e.g., translation in local language)

• Ongoing consultation: the community should be kept informed of the research, and have the power to stop the research at any time if it is found to be unacceptable for any reason.

• Participation of community members: an effort must be made to train or employ indigenous people as researchers. Communities should participate in the drafting of reports and have the final decision before the publication of any material (ISE, 1995).

2.1.1.2. Gender Sensitivity

IK is not evenly or homogeneously distributed among the various members of a local community. There is a differentiation of knowledge among individuals based on a number of factors which need to be taken into consideration when possible resources of IK are being identified (Simpson, 1994). Gender accounts for a large part of the differences in knowledge among individuals.

Gender refers to the culturally specific set of characteristics that identifies how women and men behave and how they relate to each other. It refers to the social differences, rather than biological ones, between women and men that have been learned, are changeable over time, and vary widely both within and between cultures (Adamo *et al.,* 1998). Our understanding remains limited when it comes to the role of gender in shaping the

knowledge, priorities and skills of men and women in natural resource management across diverse socio-ecological contexts; the benefits they derive and the constraints they face; and their ability to participate and be heard in the processes where management decisions are taken (Pfeiffer & Butz, 2005). Because women and men do different work and have differing responsibilities in indigenous communities, they possess differing sets of knowledge. For example, women play a crucial role in family and community survival. Their activities are typically related to gathering, growing and preparing food for subsistence, providing traditional medicine and treatment, collecting fuel, fodder and water, and child-bearing and rearing. This means that women often have the greatest vested interest in ecological sustainability (Quiroz, 1994).

Tapping the knowledge that both women and men possess is crucial in ensuring the success of development projects. Conventional development research has shown a male-bias in which researchers, usually male, focus almost exclusively on men with little consideration for the fact that women also possess important and relevant knowledge (Simpson, 1994). A lack of understanding of women's roles, and the often low social status of women in their own culture, have also contributed to the exclusion of women's input from development projects. There is a need for research that pays particular attention to whose knowledge is being considered, research that is sensitive to the differentiation of community knowledge along gender lines (Simpson, 1994).

2.1.1.3. Other Factors Accounting for the Differentiation of Knowledge

Researchers should also consider other factors such as age, education, occupation, environment, socio-economic status, experience, religion that may influence knowledge differentiation in a community (Grenier, 1998).

For example, elders are often considered to be excellent sources of IK, but the younger generations also possess knowledge relevant to their age group, which may need to be recognized. Individuals engaged in a similar pursuit, such as farmers, hunters, or herders, will have differing levels of skill and knowledge based on such things as experience, imagination, outside influences and personal aptitude (Emery, 1996). There may be local experts whose knowledge in a particular area exceeds that of other community members, or there may be highly innovative or progressive individuals who are constantly experimenting and developing new ideas and techniques (IIRR, 1996).

2.1.1.4. General Questions for Gender Analysis in IK Research

Basically, gender analysis is focused on a number of practical questions.

The first set of questions relates to efficiency. When we are doing research on development related topics, it is obvious that we want to ensure that we are putting relevant information into our analysis. For a long time, researchers assumed that women's perceptions and experiences of development processes were identical to those of men.

Even worse, it was sometimes assumed that women did not have any views or perceptions. We know now that this is not the case. Women do have experiences which are often very different from those of men, and we also know that when their views are ignored, they sometimes sabotage initiatives by refusing to take on extra workloads or by cooperating at only the most token level. This is hardly surprising, but it suggests that development projects have to be designed realistically to reflect the experiences and perceptions of both women and men.

The second set of questions has to do with equity. Most people would agree that both women and men in all countries have the right to benefit from development processes. Denying women's access to schooling or modern health care or economic opportunities simply on the basis of sex is not only grossly unfair but also creates a social rag. If women are not given the opportunity to look after themselves, this will place a greater burden on men and on the state, or more likely both.

So what are questions we need to ask when we do gender analysis? Below are only several examples of questions that need to be asked to better understand gender issues in research implementation.

Division of labor

- Who does what in a household? On a farm? In a small enterprise?
- Is some work done exclusively by one sex? If so, does this have implications for the capacity of that sex to participate in or benefit from new development strategies?

Decision making

- Who has access to financial means?
- To what extent are women involved in making decisions at household level? At community level? At national or regional level?
- Is women's perspective likely to differ from that of men?

- Access to resources
- Do women have the same access to resources such as credit, property ownership, training opportunities, education etc., as men? If not, is this likely to affect the outcome of a development initiative which is dependent on women's participation?
- Do women have access to information?

(Source: Rathgeber, 1997)

2.1.2. Methods for information collection

2.1.2.1. Methods for secondary information collection

- Previous IK research/study reports
- CC scenarios and hydro-meteorological data (temperature, rainfall) over years (minimum of 30 years)
- Succession of IK researches in the region and all over the world (research overview, IK values)
- Policy analysis.

2.1.2.2. Methods for primary information collection

- Use of PRA
- Household survey: select households to survey, combine survey and in-depth interview.
- Group discussions: Select groups that represents the community to join discussions.
- Observation: Combine topographic section survey and interviews to verify information.

2.1.3. Selection of tools for IK research

2.1.3.1. Tool No. 1: Interviewing

The word "interview" implies an interaction between two or more people. Interviews vary in style and format:

- Informal interviews without structure or control. Interviewers record details of conversations or discussions they have in the community or elsewhere. Such encounters can yield very useful information.

- Unstructured interviews based on a clear plan or a list of topics that the interviewer follows.
- Semi-structured interviews based on written lists of questions or topics that need to be covered in a particular order. These lists are called interview guides.
- Structured interviews based on a questionnaire or interview schedule which is closely followed during the interview. The course of the interview is mostly pre-determined and little leeway is left for follow-up questions.

The less an interview is structured, the more it allows for an exchange between interviewer and interviewee, leading to mutual understanding. Most forms of interviews entail a meeting between interviewers and interviewees. Interviews with some informants, such as researchers, can also be conducted by telephone. Individual interviews usually involve one interviewer and one interviewee. In the case of group interviews (e.g. interviews with several interviewees), it is useful to have several interviewers, each assigned a specific role, such as interviewer, recorder or observer.

In-depth interviews

In-depth interview is a form of interview in which questions and topics are built upon the responses to previous questions. The purpose is to uncover details about the "who", "what", "where", "when", "how" and "why" of practices, technologies, beliefs, or tools. In-depth interviews help draw out the perceptions and experiences of individuals, expressed in their own words. This is useful for gathering in-depth information on specific aspects of indigenous knowledge.

Materials: notebook, pens, initial list of topics for discussion and list of interviewees (if respondents are identified through random sampling), tape recorder (if available).

Approach:

1. Compile a list of topics. Be clear on the flow of questions and the relationship of each question to the rest.

2. Decide on a method to identify a sample of respondents. It can be based on random sampling or merely a group of people available and willing to participate at a given time. While the latter might be easier, it will give you

biased results, because certain types of people might not be available at a given time. For example, farmers might not be available for interviews at mid-morning, or women might have time only during the evening.

3. If random sampling is used, prepare a list of respondents. Make appointments with identified respondents.

4. Before each interview, explain the objectives, how the information will be used and the expected length of the discussion. About one hour is recommended. Do not forget that your interviewee's time is valuable.

5. Ask for permission in advance if you want to use a tape recorder. Also, keep written notes of the essential points of the discussion. If neither are possible, keep mental notes and record them immediately after the interview.

6. Ask questions and allow the interview to flow. But make sure you do cover the list of topics drawn up.

7. Stick to the agreed time.

8. Validate written notes with the interviewee and conduct any needed follow-up interviews.

Table 2.1: Information that needs to be collected, questions and how to record/consolidate information

Information to be collected	Questions for information collection	Information record/ consolidation
Indigenous crop varieties	Which crops are grown in your household and in the locality? How long have they been grown locally? What varieties are you growing? Where do those crops originate? (local or imported varieties). Do local crops have different characteristics from those in other places? What terms are used to call them in the local language?	Fully record information related to varieties: kinds of crops, name of varieties, local name, origin, how long they have been grown locally; Characteristics of varieties, growth time; Varieties' resilience to CC.

Information to be collected	Questions for information collection	Information record/ consolidation
Variety selection and seed treatment	How do people select varieties? Which traditional methods do people use to preserve and process the seeds? Do people encounter any difficulty in selecting varieties and preserving seeds/ seedlings? Who instructs you to choose, preserve and treat/process seeds in that way? How long have such preserving and processing methods been applied?	The details of how seeds are preserved and processed; materials used by the people for such preservation; preservation effectiveness; How long the people have used these methods.
Growing and tendering techniques	Where are crop varieties grown? How do people select land/soil? (based on what characteristics). How to grown those crops/plants? How do people tender their crops/plants? Do they use fertilizer? Which fertilizers do people often use? What is fertilizing ratio/frequency? What time in a year is tendering work conducted? What are factors used to determine times of tendering? Is there intercropping? What are crops to be and not to be intercropped? How do people allocate their cropping calendar? Is it the same the agricultural calendar provided by the government? Why? Do people based on which indicative plant/crop to allocate cropping calendar?	The people's traditional soil selection method; indicators for soil selection and growing and tendering time; Since when these methods have been applied; How to combine crops…. Method for a specific crop. What role do the people's traditional methods play in CC adaptation?

Information to be collected	Questions for information collection	Information record/ consolidation
Pest and disease prevention	What are difficulties faced by the people in pest and disease prevention? What are common pests and diseases? How do they prevent them? Do they use chemicals? Do people have any specialized method for such pests? What do people use for pest and disease prevention? Do farmers grow pest-repelling plants? Which varieties? (name of plants used by people, their local name)	Pests: traditional preventive methods; materials used; natural enemy plants (local names if available); Time/origin of the method.
Evaluation on crops/animals	How do people evaluate crops/animals? For what are such crops used? Which parts of the plants are used? Which plants are used as medicines for human and animal? Where does knowledge of such medicinal plants come from? Which criteria do people apply to evaluate and select crops/animals in their cultivation system?	Usage of plants. Medicinal plants, how to use them, if available. Criteria for people's evaluation and selection of crops.
Weather forecast and natural disaster risk prevention	How do extreme weather events happen locally? Do people have any experience to forecast weather as well as extreme climate events? Since when have such forecast and prediction ways been used? Are they still useful now? Why? What do people do to be prepared for extreme weather events? How do people address after extreme weather events?	Bases for people to predict, forecast extreme weather events (indicative plants/animals). Accuracy of the methods. People's traditional methods to adapt to extreme weather events.

2.1.3.2. Tool No. 2: Group discussion

Picture 2.1: Group discussion in Khau Tong village

Discussion with groups of 05 (five) to 10 (ten) knowledgeable community members covering one or several topics. The purpose is to generate information, to build consensus, to validate information gathered by other means or to clarify information in documents lacking details. Group discussions can provide IK data on farming and other livelihood practices, leadership structures and decision-making patterns, health practices and delivery systems, traditional medicines, labor sharing arrangements, local indicators of poverty and socio-economic standing, indigenous taxonomic schemes, and other information. Group discussions can also help the facilitator learn local terms and concepts that might have no direct equivalent in the outsider's language. When used in combination with other data gathering techniques, the information obtained can be of very good quality.

The method is inexpensive and relatively easy. Group discussions foster participation and partnership in information sharing and analysis and generate information beyond what can be gleaned from interviews. When faced with conflicting information, several people can present bits of data until the group has enough information to reach consensus.

Materials: paper, marking pens, masking tape, chalkboard, chalk and eraser.

Approach

1. Review available information on the community. Determine what data are needed.

2. Consult community leaders. Explain the purpose of the data collection and discuss the information you want to collect.

3. Determine, in consultation with community leaders, the criteria for group selection. Ideally, group members come from various walks of life and socio-economic categories, representing formal and informal community organizations. The composition of the group will depend on the topic.

4. Let community leaders identify people in the community who fit the criteria. Be on the lookout for biases; make sure that people from the most remote village or the poorest group in the community are represented. Otherwise, the views and perceptions of the poor are not incorporated.

5. Prepare for the meeting: Set the date, time and venue; Prepare guide questions which will serve to steer discussions; Personally visit the group members to seek their agreement to participate in the discussion. Explain the purpose and objectives of the meeting.

6. At the start of the meeting, introduce yourself and all group members. Carefully explain again the purpose and objectives of the discussion and how the information will be used. Mention the benefits that the community might derive from the meeting.

7. During the meeting:

- Ask the first guide question. Solicit participation from all group members. Make sure discussions are not dominated by a few people.
- When consensus is reached, or when an issue cannot be resolved, introduce a new guide question.
- Record major points and the results of consensus.

8. At the close of the meeting, summarize major findings and consensus.

9. Inform other members of the community about the results.

Dos and Don'ts:

- Do build rapport with group members.
- Do maintain a sense of humor while facilitating.

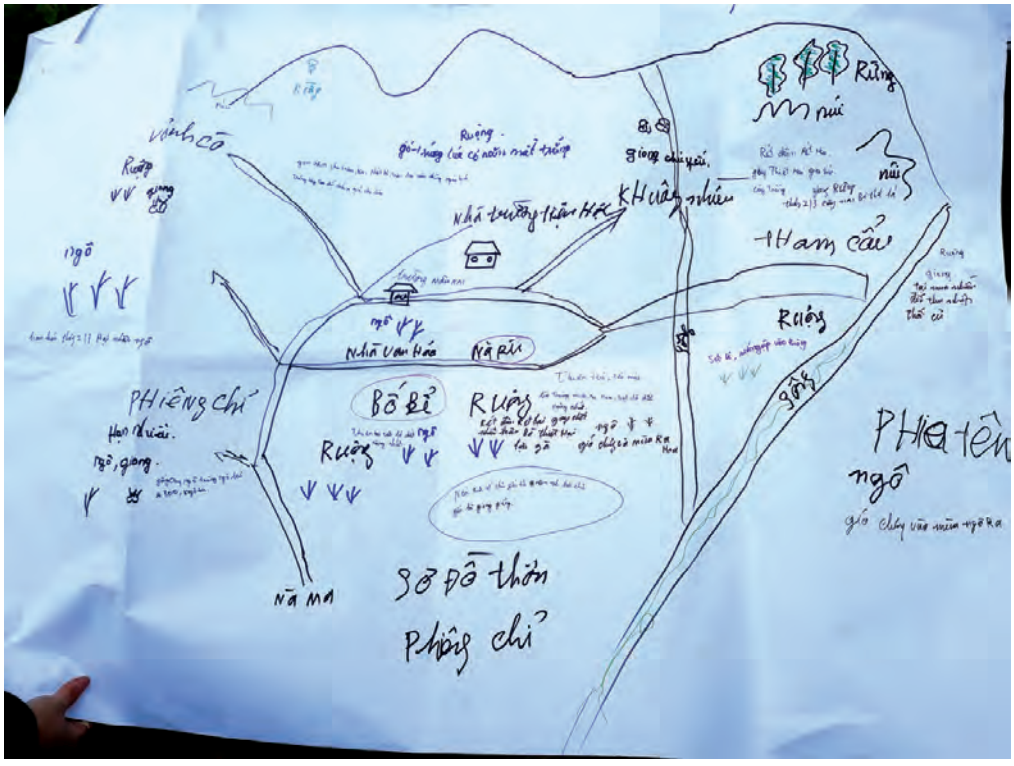
- Don't let one or a few members of the group monopolize the discussion.
- Don't create an impression that you are an expert on the topic (even if you are an expert).

Gathered information should be recorded in Table 2.2.

Table 2.2: Information of crops and animals and their CC adaptation characteristics

Name of crops/ animals	Local names of varieties	How long have they been grown in the locality? (since which year)	Yield/ Income	Variety characteristics	CC adaptation ability
.....	.....	.....	.....	.....	.....
.....	.....	.....	.....	.....	.....

2.1.3.3. Tool No. 3: Mapping



Picture 2.1: Example of Phieng Chi village's map

Description: A method for collecting information on where certain resources or features are located. The purpose is to help identify and analyze the distribution of and the relationships between specific resources or features. The maps can show topography, soils, water, forest products, property regimes, land use (including where food is gathered), ecosystems, socio-economic data such as location of indigenous health practitioners, location of medicinal plants, common diseases, ritual sites, location of traditional birth attendants, and more.

Participatory mapping helps outsiders and community members identify, locate, and classify resources and features, revealing their importance and usefulness from the local people's point of view. Mapping reveals patterns of spatial organization as well as constraints and opportunities. It can be used to collect baseline data and to monitor change in resources and patterns of use. It can also be used to improve resource management strategies or to design new systems.

Materials: paper, pencil, chalkboard, chalk. Any surface can be used. The map can be drawn with chalk on a concrete floor, or drawn on the ground with a stick. Some villagers have made detailed three-dimensional models using sand, earth, and stones.

Possible approach:

1. Define purpose and scope of the mapping exercise.
2. Select key informants.
3. Together, define scale and boundaries of the map. The scale of the map will depend on the objectives of the exercise and the drawing surfaces available.
4. Determine resources or features to be mapped.
5. Prepare a base map if none exists. To do so, ask people to identify and draw key landmarks or reference points and reference lines-for instance, hills, roads, and rivers.
6. Ask participants to locate selected resources and features on the map. Symbols and colors can be used to represent quantity and quality of the different categories.

7. Revise the map.
8. Copy the final map on paper or take a photograph.
9. Leave a copy of the map with the community.

Questions for discussion guiding and information collection

- What are local soil, terrain types?
- Signals of CC (higher temperature, much rain in the wet season and less rain in dry season etc.) and natural disasters (storm, flood, drought, bitter cold, dangerous cold etc.). What are changes in natural disaster trends in the last 30 years?
- What are disasters that often hit the locality?
- What are the most affected areas? What solutions/measures do people have to adapt to climate and disaster change in a long time? What do men often do? What do women often do? Why? Is there a need for a change? If so, what should men and women do to well support each other?
- On each type of terrain, what crops do people grow? Why?
- What are the effects of such growing methods in CC adaptation and Disaster Risk Reduction?
- From whom do people learn such growing methods? (they invented or were instructed by whom?
- What are the effects of crops/animals in the model?
- What crops are combined with each other? Why?
- What crops are not combined? Why not?

2.1.3.4. Tool No. 4: Cropping, natural disaster calendar

Develop cropping, natural disaster calendars to collect information about indigenous crops/animals, their adaptive characteristics toward CC, how to arrange cropping seasons and foundation of such arrangement. Identify experience in weather forecast, forecast/prediction basis to introduce measures to adapt to natural disaster/diseases and compare the people's experience in cropping season arrangement against cropping calendar published by state agencies for similarities and differences.

Approach

Month / Crops	1	2	3	4	5	6	7	8	9	10	11	12
Tea		Insects										
Domestic												
Pig		Diseases									Diseases	
Chicken		Diseases									Diseases	
Duck		Diseases									Diseases	
Cattle/Bovine												
Fish												
Weather												
Dry												
Hailstorm												
Flood												

Figure 2.3: Example of a cropping calendar

1. Identify the type of indigenous knowledge you want to document, such as weather, common diseases, social and economic activities, household cash flow, agricultural activities, and food availability.
2. Draw a table of 12 columns (each for a month) and rows on which discussion topics are written.
3. With each topic, discuss and select by consensus the most suitable information that best represent the events "which are most frequently or commonly observed with the most people affected".

Allow local terms to be used to make it easier for participants to understand.

4. When the chart is completed, ask the group to analyze the interrelationships through time and discuss the results with a view to identifying implications and possible actions and measures.
5. Keep a copy for future reference. Chart of cropping and natural disaster calendars can also be used for monitoring and evaluating interventions.

Notes

• Use local terms.

• Don't use scientific terms.

Guidance to collect information

- Compile a list of local crops/animals.
- Growing and raising calendar of those local crops and animals (draw cropping calendar)
- How long have such local crops/animals been grown/raised? Where did they originate?
- Among the above crops and animals, which ones are indigenous? What are their local names?
- What are varieties' characteristics and values in CC adaptation?
- What are local people's experience, basis to allocate cropping calendar in such way? Is there any shifting in recent crops? If so, how?
- What are local extreme weather events?
- How do local extreme weather events happen (starting and ending time)?
- How do local people forecast weather and disaster risks? Is men's experience different from that of women? If both sexes give forecast, whose opinions will often be appreciated? Which opinion was proved right by what actually happened? Was there any change in attitude toward opinions in following seasons?
- What are weather forecasts, predictions based on? Currently, are such previous weather forecast experience still useful?

- What are methods often used by the people for disaster risk prevention and CC adaptation? Who gives out or makes decisions on such measures, men or women? Are men's methods different from those of women?
- What is the basis to select crops and arrange crops/animals?
- What time do pests and disease often happen to local crops and animals?
- How do people prevent and address pests and diseases in their crops and animals? Do they use plant protection medicines? Who decides this, men or women? Does such decision making improve or reduce the reputation of the decision maker?
- Do people grow pest-repelling plants?

2.1.3.5. Tool No. 5: Transect

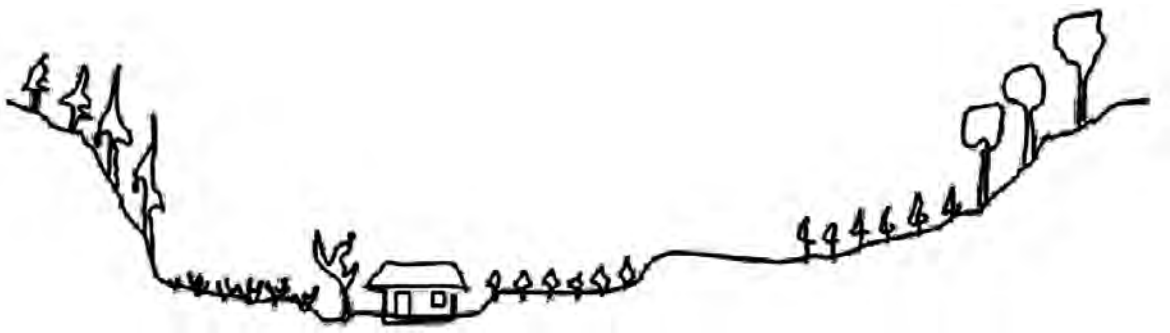


Figure 2.4: Example of a transect map

This is a method of collecting information about major land-use zones within a community. Involves walking or driving along a carefully selected path that cuts across the main geographic features of a community or territory to compare main features, resources, uses, problems, and opportunities of different zones. The purpose is to provide a picture of how natural resources are managed and used by a community, and to help identify the problems and opportunities inherent to each zone.

A transect walk is a useful tool for tapping local people's knowledge about land use, natural resources, soil types, problems, and possible solutions. It can yield a wealth of information on IK which might be overlooked by

other data-gathering methods, especially if the informants classify and record the information.

Materials: community map, flip chart (large sheets of paper attached to an easel), colored marking pens, notebooks, pens.

Approach

1. Find key informants who are knowledgeable and willing to participate. Discuss the different information the project team would like to gather from the transect (crops, land use, trees, soil, water, problems, opportunities, etc.).

2. Identify on the community map the route to be taken for the transect. The routes should cover all major ecological and production zones. A large and highly variable community might require more than one transect.

3. Walk or drive with the informants along the transect route. Let the key informants give information relating to the categories selected. Ask questions on additional factors that might come up during the walk or drive. Or become an observer while informants do the recording.

4. Transfer field data to a clean sheet and add illustrations.

5. Validate data with key informants.

The information collected are recorded/compiled into Tables 2.3 and 2.4.

- Local community's advantages and disadvantages
- Natural conditions (soil, terrain, etc.)
- Distribution of crops/animals by soil/ terrain types
- Symbols of CC, natural disasters and places which are often affected by disaster risks
- What are indigenous crops/ animals?
- Characteristics of crops/animals, their ability to adapt local conditions
- The people's experience applied in crop growing and animal raising
- Basis for the crop/animal distribution?
- Why do people distribute crops/animals in the way as surveyed?

Table 2.4: Distribution of crops by terrain/ soil types

	Farm land	Terrace field	House-hold garden	Vacant land	Hill farm	Natural forest	Planted forest
Natural conditions	Soil of black color, good fertility	....	....	....	....	....	....
Crop distribution	Rice, maize	....	....	....	....	....	....
Symbols of CC, Disaster risk	Drought	....	....	....	....	....	....
Difficulty	Water shortage	....	....	....	....	....	....
Solution	Grow local xerophilous varieties	....	....	....	....	....	....

Table 2.5: IK of cultivation on terrain, soil types

Type of soil/ terrain	Crops/ animals	Tendering technique	Applicable time	Origin	CC adaptation characteristics
Natural forest land	Schizostachyum aciculare, Chukrasia tabularis, styrax (Ficus religiosa), cardamon (Amomum tsao-ko)	Mixed plantation		Locally developed	Maintain moisture for soil, prevent erosion
....	....	....	....	....	....

2.2. Use of IK in agroecological practices for CC adaptation

2.2.1. Criteria for selection of agroecological practices that apply IK for CC adaptation

The set of criteria used for selection and evaluation on agroecological practices which apply IK for CC adaptation consists of 5 criteria as following:

(1) Efficiency in CC adaptation and rehabilitation

- Resilient to natural disasters, diseases, CC and reduce human, asset and environmental damages and losses
- Able to reduce the level or intensity of greenhouse gas emission
- Energy saving and consumption efficiency
- Contribute to reduce risks that the community is affected by CC impacts, and thereby improve the community's capacity to adapt CC impacts

(2) Economic efficiency and sustainability

Apart from being adaptive to CC, good practices or experiences should prove economically positive benefits/impacts including:

- Increase/ diversify income sources and job opportunity generation
- Increase number of beneficiaries
- Increase labor productivity and reduce investment cost
- Possible to apply, combine with scientific techniques

(3) Institutional and social efficiency and sustainability

- Suitable with the community's culture and customs, accepted by the community
- In line with local institutional arrangements and policies
- Contribute to poverty reduction, generate on-site jobs for women
- Involve active participation of local community, especially vulnerable groups such as ethnic minorities, poor people, women, the elders etc. in the whole project cycle from design to implementation and monitoring and evaluation

(4) Environmental efficiency and sustainability

- Protect and improve land and water environment
- Contribute to the preservation of natural resources, valuable genes and biodiversity.

(5) Extension possibility

- Good practices/models are representative, accepted and supported by the community. The results of good practices/models have positive impacts on the community.
- Problems are solved by implementing models representing many regions and communities.
- Implementation activities, guidelines developed in the framework for the exercise of good models/practices are simple, understandable and acceptable and easy to apply at the community level, especially when it comes to technical activities and guidelines.

2.2.2. Implementation

2.2.2.1. Agenda for identification, evaluation and experiment

Step 1: Identify indigenous knowledge

- Research and identify information and experience of the local community using research tools via working with the community
- Record all information and experience of the local people relevant to the identified problems.

Step 2: Evaluate the efficiency and sustainability of IK in CC context

- Not all of IK collected from the community is useful and especially adaptive to CC as well as can survive in sustainable development. Even some of IK are adverse to sustainable development. Thus, there is a need to screen out beneficial IK in CC adaptation.
- When evaluating IK in CC adaptation, learning why the people use such IK to adapt CC and how such IK adapts to CC is vital. For example, we can ask:

+ How do local techniques/varieties you are using adapt in extreme weather events (such as drought, long lasting bitter cold, dangerous cold, etc.) Who (men or women) is involved in cultivating / caring (animals) during the process? Does such involvement cost much energy from that person? Is there any other possible way to assign work to both men and women so that the work burden would not on one sex's shoulder only?

+ Thereby IK's CC adaptive characteristics could be identified. If IK is beneficial to the community in CC adaptation and sustainable development, it could be promoted/developed.

Note: At step 1 and step 2, it is necessary to use the set of criteria in section 2.3.1 to identify and evaluate the suitability of IK.

Step 3: Experiment IK

- IK is normally still useful but can be improved. Improvement helps to increase the efficiency of IK (minor changes in a system can improve efficiency of the whole system).
- Experiments could be done in form of researches, local actual experiments, farm field study etc.
- Experiment for combination, flexible and effective application of IK and new knowledge (scientific and technical knowledge) to increase values of IK in CC adaptation.
- There are effective IK that cannot be improved or needs no improvement and are still reasonably applied.

Experimenting IK includes the following steps:

Step 3.1: Develop an implementation plan

Project officer group, district, commune staffs and local people's representatives meet and discuss to:

- Identify/select households to participate in model implementation
- Determine model implementation time
- Determine area/scope of model application
- Determine project's support/assistance (if any) and the local people's contribution

Step 3.2: Implementation arrangement

Implementation arrangement activities always involve the participation of local community, authority, mass organizations, district technical staffs and project officers (if any)

- Villages organize meetings to select households and locations for model implementation: Enthusiastic, willing households, priority given to poor and near-poor household and encourage the involvement of women; survey, appraise and collect basic information of households' production status.
- Identify the households' status, difficulties and experience with cropping model in extreme climate, thereby determine solutions: techniques and the model's CC adaptive factors.
- Assign tasks to household group's members, project officers, and commune staff in charge of model implementation, coordination, monitoring and evaluation.
- Provide guidance on micro-organic fertilizer composting techniques to use for plants/crops.
- Conduct site training by production stages.
- Provide guidance on model exercise.
- During model exercise course, apply some indigenous knowledge/ experience of local people in production.
- Monitor, supervise the model's participatory implementation by district technical staff, commune staff, project officers, village leaders, village's women union, households to timely provide assistance and ensure model implementation and good results.
- Organize farm field school to evaluate the model and extension orientation.
- Evaluate model implementation results: Evaluate by criteria such as economic, social and environmental efficiency, the model's capacity to adapt CC.

2.2.2.2. Agenda to extend agroecology implementation/model using IK

Upon their collection, experiment and proved to be valuable in CC adaptation, IK shall be extended in local practices.

Replicating IK shall facilitate easy application by local people and thereby promote the community's experience, improve their capacity to self-control in CC adaptation. Agroecological practices/model extension includes the following steps:

- Step 1: Extension at village, commune levels

IK and agroecological practices, after being evaluated to be efficient and adaptive in experimenting step, shall be communicated and extended at village, commune level by local village, commune authorities, in coordination with mass organizations.

- Step 2: Extension on large scale (district, provincial levels)

IK/agroecological practices, after being evaluated to be efficient and adaptive in extension step at village, commune levels, shall be communicated to and replicated to communes, districts with similar ecological and cultural conditions by the authorities of neighboring communes, district- and provincial level agencies.

Chapter III: SOME MODELS OF TYPICAL AGROECOLOGICAL PRACTICES USING IK FOR CC ADAPTATION

3.1. Models implemented by the ADC in cooperation with partners

(1) Model of banana (Musa sp.*) intercropped with medicinal plants on steep land*

Implemented by the Agriculture and Forestry Research & Development Center for Mountainous Region (ADC)

Picture 2.5: Banana (*Musa* sp) intercropped with medicinal plants

Ethnic group: Tay, Dao
Project area: Thanh Van and Mai Lap communes, Cho Moi district, Bac Kan province
Scale: 50,000m^2.

EVALUATION ON THE MODEL'S EFFICIENCY

Efficiency in CC adaptation and rehabilitation

Intercropping of *Musa* and ginger (*Zingiber officinale*) and other medicinal plants such as *Ardisia silvestris* and Jiaogulan (*Gynostemma pentaphyllum*) helped to well adapt to the increasing drought situation in Bac Kan in the context of climate change. The intercropping method also helped to increase soil cover, reduce erosion in rainy weather, increase soil's water retention, which made it adapt better than growing one type of crop/plant only. Discussion with local people revealed that the tendency of increasing temperature did not cause much impact on the growth of the model since high temperature and extreme sunny condition made the plants grow better and their fruits become ripe faster.

- Shorter and warmer winter time facilitated growth of *Musa*, reduces waiting time before harvest and helps to yield fruit with a better look.
- *Musa* also barely suffered impacts of unexpected rain or change in rainfall over seasons. However, the occurrence of long bitter cold waves has made the plants wither.
- Shifting cropping pattern to respond to climate change was vital for the local socio-economic development.

Economic efficiency and sustainability

- Transport cost was lowered since the products are consumed locally and at peak season when *musa* price is high, traders came to buy at farms.
- In addition, using the plants' trunks and leaves as micro-organic fertilizer or feed for pigs, chickens, cattle (cows/buffaloes) and fish also helped to save costs for the households. At the same time, the participants easily applied the indigenous knowledge obtained via training or self-learning at the model/ in group meetings for development of their

households' models. It therefore significantly reduced investment costs for seedling, techniques as well as technologies.

- Total net income of the model was over VND 50 million/ha/year, compared to that of growing maize only (total net income was approximately VND 25 million/ha/year)

Institutional - social efficiency and sustainability

- There was involvement of local people (men, women, poor households, etc.), local authorities and technical agencies during the model implementation, which facilitated better implementation of information correspondence between the authority and local people.
- The local people and staff received production technical capacity building via their attendance in training classes, which made them more active in production activities. There was a harmonious combination between IK with new sciences and techniques, which would facilitate the model's extension and sustainability.
- Increased income thanks to the model helped the households escape from poverty, improve their living conditions such as: children had breakfast before going to school, daily living costs increased, people could afford TVs for news and entertainment, refrigerators for food preservation, motorbikes for easier travel and women all have cell-phones for communication and information sharing.
- Women's role in making livelihood decisions was improved when they had the right to decide how to use the income from the model and to extend the production area in the following year.
- Medicinal plants such as ginger, *Ardisia silvestris* and Jiaogulan are valuable medicines which are used in many traditional medicinal prescriptions. For example, *Ardisia silvestris* leaves are used in combination with Eugenia (*Cleistocalyx operculatus*) leaves and *Styphnolobium japonicum* flower to make shower water for children with tinea. On the other hand, the Dao people slice *Ardisia silvestris* roots, dry and then soak into wine, the output is said to be blood tonic and can help to treat dysentery, pharynx and muscular pain.

Environmental efficiency and sustainability

- Compared with sole cropping in the past, the model helped to increase land cover, reduce soil washing-off and erosion, moisturize

soil and improve water sources from streams for production since the model's plants grew and developed throughout the year and left no vacant time for land, the business cycle was 3 - 5 years.

- Intercropping of various crops on the same area helped to reduce weed, and consequently reduced the amount of plant protection products/pesticides used.
- Contributed to preserve genes of indigenous herbal and medicinal plants and *musa*.
- Took advantage of by-products from agricultural and livestock activities and from the model to produce micro-organic fertilizer which provided humus for the model plants, limiting the burning of by-products to cause smoke, dust and environmental pollution.

Extension possibility

- The model of *musa* intercropped with medicinal plants have been piloted and extended from 2014 to 2019 in Thanh Van and Mai Lap communes. Medicinal plants intercropped with *musa* and then extended include: *Zingiber officinale*, Jiaogulan, *Ardisia silvestris*, *Alpinia* etc. The intercropping model area is now over 200 ha. There have been numerous orders for Jiaogulan, *Ardisia silvestris*, which is the basis for the continued extension of the model.

APPLIED INDIGENOUS KNOWLEDGE

- Medicinal plants such as ginger, Jiaogulan, *Ardisia silvestris*, *Alpinia* and *Musa* are local indigenous crops with long tradition.
- Preserve ginger from previous crop season with sand in the space under floor in dark condition. Use sprouts and grow in the soil of good fertility.
- Medicinal plants such as Jiaogulan, *Ardisia silvestris* were collected and domesticated from forest using folk experience.
- Intercropping of medicinal plant such as ginger (sciophytic plant) and *musa* is a good combination which yields good cultivation effectiveness. Use of micro-organic fertilizer composted and manure helps to improve soil and prevent erosion.
- Grow plants at the beginning of rainy season for better water supply.

- Intercrop with short-term crops/plants. Selection of intercropping time of ginger or medicinal plants (April in first or second year) to reduce weed or erosion is an indigenous knowledge-technique apply by many local people.

CHALLENGES AND LESSONS LEARNED

Challenges

- The biggest challenge in the model implementation was the transport of fertilizers, seedlings and harvested products due to steep terrain.
- For model extension, accessing funding source is vital but still, however, now limited. Therefore, there is a need for policies on using, mobilizing funds from relevant development projects, plans and programs (Programs 135, 30A, Provincial Socio-Economic Development Program).

Lessons learned

- The approach should be based on indigenous knowledge and consultation with local people. The model design should be done with criteria of making use of suitable indigenous knowledge, which facilitate model implementation; making local people active and flexible to be able to adapt to external unfavorable conditions, adverse impacts caused by natural disasters and climate change.
- Supervised "hands-on" training method applied for people was a suitable approach.
- The criteria for the selection of participating households, implementation location should be clear and receive consensus from local people so that the project objectives could be achieved, especially in the projects aiming at poor households and women.
- Households participating in the model should record adequate details in monitoring book to facilitate monitoring of the model's growth and pest control, experience sharing and recognition of economic results.
- There should be regular monitoring to detect households' mistakes and timely address them.

- Assign specific tasks to participants in the model for regular cross-monitoring, which would help to keep the model implementation on track.
- Request participating households to give a pledge to make them more accountable during implementation course.

(2). Model of maize intercropped with peanut

Implemented by the Agriculture and Forestry Research & Development Center for Mountainous Region (ADC).
Ethnic group: Tay.
Project area: Tam Son town, Quan Ba district, Ha Giang province.
Scale: 10,000m^2 with participation of 30 households.
Cropping season: August - December.

Picture 2.6: Maize intercropped with peanut

EVALUATION ON THE MODEL'S EFFICIENCY

Efficiency in CC adaptation and rehabilitation

- The local red peanut (*Arachis hypogaea* sp.) was highly resilient to drought and helped to limit pests, which resulted in reduced use of pesticide.
- The selection of crops which can supplement each other (peanut retained soil protein) increased soil fertility and therefore contributed to better growth of maize. It was also suitable with local ecological conditions such as short growth time, which made land freed in time for autumn rice crop. The crops also quickly covered cultivation area and resist drought and pests well.
- Techniques of intercropping, allocating density of maize (*Zea mays* L. ssp. *mays*) and peanut helped to retain moisture in soil (for maize, distance was 1.1 - 1.2 m between wide rows and 0.5 m between narrow ones, 0.25 m between a plant to another; grew peanut in between wide rows of maize with distance of 0.35 m between rows and 0.12 m between one plant to another). On the other hand, intercropping of the two helped to increase soil cover, moisture retaining and limit the impacts of local drought.

Economic efficiency and sustainability

- The model results showed that intercropping of maize and peanut generated income of about VND 6 million/1000m^2 on average and that income from the secondary crop (peanut) could compensate the model's initial investment cost.
- Despite unusual weather conditions at the beginning of cropping time compared with previous years (long drought) which affected growth and yield of the model's plants, in comparison with maize grown in the non-model area, the model's maize had dense fruits, kernels of even length and saw no defective fruits.
- The model results revealed effects of intercropping legume with primary crop (maize), which served as basis to form cropping pattern for stable yield thanks to legume's advantages. It also helped to diversify crops in one area, limit impacts caused by pests and reduce

risks due to climate change impacts. Compared with no cultivation on 1-season land in the past, the economic efficiency increased by 100% (VND 6 million/1000m^2).

- The model helped to diversify local people's livelihood activities.

Institutional - social efficiency and sustainability

- There was involvement of local people and authorities as well as technical agencies during the model implementation, which facilitated better implementation of information correspondence between the authority and local people.
- The model helped generate jobs for women during spring season, reducing time when they had to travel to other places to work by 50%.
- The local people and staff (30 farmers and commune staffs) received production technical capacity building via their attendance in training classes, which made them more active in production activities.
- The model's peanut product was a source of food that contributed to the preservation of traditions and culture as the Tay people use peanut (local red peanut variety) as ingredients of dishes in their traditional festivals and special occasions.
- Training and guidance were provided so that the participating households could easily apply tendering, pest prevention, harvesting, storing and processing techniques and earn products of the best yield and quality.

Environmental efficiency and sustainability

- The model was relatively friendly to the environment thanks to the use of organic fertilizers in harmony with inorganic ones, which consequently reduced risk of soil degradation.
- Increase soil cover, reduce soil washing-off, retain moisture, improve fertility and make soil porous as peanut stem was used as site manure.
- Sterile soil should be improved by increasing the use of organic fertilizer to raise soil humus.

Extension possibility

- Hands-on training provided on the farm in combination with visual materials helped the participating households easily applied the trained techniques.
- Red peanut from the model is a food product that contributed to the preservation of traditional cuisine of Tay and Dao ethnic groups in special occasions and holidays, and thus, the model was extended to the neighboring villages and communes of the district.

APPLIED INDIGENOUS KNOWLEDGE

- Use of local variety which is relatively resilient to pest and external conditions.
- During the course of model implementation, where there was serious drought, the farmers only cut weeds on the surface, without plucking them all to retain moisture in the soil.
- When harvesting maize, if it was ripe during long rain waves, the silk should be removed and kernels should be plucked downward to prevent water getting inside and collected for drying on sunny days.
- The people often dry peanut and store them in dry places for seed preservation.
- Maize could be preserved with the mixture of bead-tree leaves, oleander leaves and dry maize husks and stalks. The mixture would be placed in drums/buckets and covered with a layer of ash and sealed.
- Use crushed bead-tree leaves and peach leaves mixed with urine to repel pests.

CHALLENGES AND LESSONS LEARNED

Challenges

- Despite a long drought at the beginning, crop varieties were highly resilient and adaptive to drought, which helped to ensure yield and productivity.
- The partitioned terrain and formation of different climate sub-regions, the unavailability of weather forecasts for each sub-region did hinder the model implementation (crop selection, cropping time determination, suitable tendering etc.) and extension.

- A part of the local people was not confident enough to participate in the mode.
- Change the local people's cultivation practice from sole cropping to intercropping as the latter was supposed to be difficult for implementation.

Lessons learned

- The model should originate from local people's demand and receive the authority's support.
- Supervised "hands-on" training method applied for people was a suitable approach. It would be easier for the farmers to understand if they can watch, listen and practice what was trained at the same time.
- The criteria for the selection of participating households, implementation location should be clear and receive consensus from local people so that the project objectives could be achieved, especially in the projects aiming at poor households and women. Request participating households to give a pledge to make them more accountable during implementation course.
- The cultural features as well as local people's experience in detecting unusual weather events such as rain, thundershower, drought, etc. during cultivation time should be taken into consideration in all interventions.
- Assign specific tasks to participants in the model for regular cross-monitoring, which would help to keep the model implementation on track.

(3). Model of pachyrrhizus sp intercropped with taro

Implemented by the Ha Giang Center for Community Mountain Development, PLAN organization.

Technical consultant: Agriculture and Forestry Research & Development Center for Mountainous Region (ADC).

Ethnic group: H'mong.

Project area: Can Ty commune, Quan Ba district, Ha Giang province

Scale: 10,000m^2.

Cropping season: April.

Implementation time: April 2013 - November 2013.

Picture 2.7: Maize intercropped with pachyrrhizus and taro

EVALUATION ON THE MODEL'S EFFICIENCY

Efficiency in CC adaptation and rehabilitation

- The combination of local crops such as taro (*Colocasia esculenta*) and pachyrrhizus (*Pachyrrhizus erosus*) suited the local cultivation conditions with hybrid maize NK4300 variety which was highly drought resilient.
- The model strengthened soil moisture retaining, which helped the crops better adapt to drought

- The model was also a solution to shift from sole cropping to intercropping, increase production yield and help local people to have better response to climate change.

Economic efficiency and sustainability

- In the communes not yet seeing industrial and service development, to take advantage of farmers' free time, promoting agriculture development via product diversification and quality improvement is an important solution to create jobs and generate additional income for local people. The model of maize intercropped with taro and pachyrrhizus did help to diversify income sources and create more local jobs.
- It is possible to combine scientific knowledge to generate crop varieties of good quality, helping the community control seedling source (pachyrrhizus and taro) and become independent of external sources, which reduced investment costs and increased production efficiency.
- Intercropping of maize and taro and pachyrrhizus helped reduce weed and increase soil moisture, therefore saved water for irrigation.
- Increasing land use efficiency thanks to the diversity of crops on a land unit at the same time, the model generated a profit of VND 6.5 million/ 1000 m^2, twice as much as that of maize sole cropping.

Institutional - social efficiency and sustainability

- There was involvement of local people and authorities as well as technical agencies during the model implementation, which improved information correspondence between the authority and local people and the ethnic minority people's voice.
- The local people and staff received production technical capacity building via their attendance in training classes, which made them more active in production activities.
- The model helped to create jobs for local labors, which suited local authority and people's need and were accepted by the community.
- The model is included in the local socio-economic development strategy.

Environmental efficiency and sustainability

- The model involved no use of pesticides, and consequently reduced environmental pollution, emission causing CC and produced hygiene and safe products for consumers and at the same time raised product value.
- The model used indigenous pachyrrhizus variety (with growth time of 6-7 months compared to 3-4 months of hybrid variety), highly resilient to external conditions, which increased soil cover time, especially in rainy season. The plants in the model are stratified, which helped increase soil cover time, retain moisture and prevent erosion. The legume plant (pachyrrhizus) is known to self-contain protein, contributing to the improvement of soil fertility.
- Participating in the model, the farmers were guided to compost micro-organic fertilizer from agricultural wastes to manure their crops, which functioned to improve soil, retain moisture and minimize impacts caused by local drought. This helped to raise the local people's awareness of effective use and exploitation of agricultural waste for environmental pollution reduction.
- Maintaining and applying indigenous taro and pachyrrhizus varieties helped to protect natural resources as well as biodiversity.

Extension possibility

- The model applied simple technical measures which were easy for people to follow and extend. This has been scaled up in neighboring villages and communes having the similar soil conditions.

APPLIED INDIGENOUS KNOWLEDGE

- Intercropping of pachyrrhizus and taro into cultivation area of drought-resilient maize variety NK 4300.
- Intercropping of crops with different growth time lengths (maize - 115 days, pachyrrhizus - 180-200 days) to increase soil cover and retain moisture. Pachyrrhizus also helps to anchor protein in soil to supplement maize and taro.
- The local people self-preserved taro and pachyrrhizus seedling using traditional methods, which made them less dependent on seedling source and increased the community's control.

CHALLENGES AND LESSONS LEARNED

Challenges

- Local level still lacked service systems regarding market information, seedling, fertilizer, which limited the farmers' production.
- Land fund in all villages was quite limited due to significant land encroaching situation. The land plots came in between villages, which made it impossible to select households with concentrated land for model implementation.
- The local people did not take initiation to seek markets for their products, leading to their orientation of small-scale production for household consumption only.
- A number of the local people were not confident enough to participate in the mode.
- Change the local people's cultivation habits

Lessons learned

- Supervised "hands-on" training method applied for people was a suitable approach.
- The criteria for the selection of participating households, implementation location should be clear and receive consensus from local people.
- Apply participatory approach, involve cadres at village, commune and district levels as well as core farmers in model implementation.
- The model implementation should focus on capacity building for the local people.
- Households participating in the model should record adequate details in their monitoring book. There should be regular monitoring to detect households' mistakes and timely address them. Assign specific tasks to participants in the model and request participating households to give a pledge on model implementation.

- Compost micro-organic fertilizer for using during tendering course and following years.

(4). Model of drought resilient green bean

Implemented by the Agriculture and Forestry Research & Development Center for Mountainous Region (ADC).

Ethnic group: Tay, Dao.

Project area: Thanh Van and Mai Lap communes, Cho Moi district, Bac Kan province.

Scale: 120,000m^2.

Implementation time: Spring crop season 2015 - 2019.

Picture 2.8: Model of drought resilient green bean

EVALUATION ON THE MODEL'S EFFICIENCY

Efficiency in CC adaptation and rehabilitation

- Erratic developments of the climate will intensify in the coming time, the extremeness and events considered to be consequences of CC such as irregular, bitter or dangerous cold waves, drought etc. will continue and scale up across regions and territories. This means agriculture production will be pushed to a harder situation, and the close dependence on natural weather makes it more unstable than ever.

- The model of drought resilient green bean (*Vigna radiata* (L) sp.) mostly offers efficiency in strengthening the people's adaptation capacity in agriculture production and minimize losses caused by CC adverse impacts such as: Strengthen the crop's resilience to pests and drought by determining suitable cropping time, balanced fertilizers (increased potassium and reduced protein), lowering beds, making ditches around the field to reduce drought and applying local varieties to strengthen resilience to pests; Improve soil by using micro-organic fertilizer and microorganisms around the roots which can consolidate protein; use the plant stalk and leaves as fertilizer and release land in time for cultivation of the next crop.
- Therefore, people have more income and stay active in their spring crop production, which increases the community's resilience to drought and significantly reduces vulnerability to climate change risks.

Economic efficiency and sustainability

- The area of vacant land or land underutilized in spring crop season is quite large (about 25 - 30 ha), causing such a resource waste. The exploitation of vacant land in the spring crop season and conversion a part of the underutilized area to grow green bean, with short growth time (70-75 days till harvest) have helped to increase income for ethnic minority household, which is approximately VND 3.4 - 3.8 million /1000m^2. This is not a small amount of income, especially in the context where local drought and heat waves cause a reduction in yield and lean harvest on some spring rice areas without controlled irrigation like spring crop in 2 project communes.
- Green bean plant stalk and leaves also provide a significant amount of protein to the autumn rice crop, and thus reduce fertilizer cost (by 20%). In addition to economic benefits, the model also contributes to social stabilization by creating more local jobs and easing burden on women's shoulder.

Institutional - social efficiency and sustainability

- Exploiting abundant labors and farmers' free time in agriculture production is a big concern. In two project communes where

industrial and service development has not been seen, to take advantage of farmers' free time, promoting agriculture development via product diversification and quality improvement is an important solution to create jobs and generate additional income for farmers and additional assets to the society. There is a fact that to have more income to afford their living, children's tuition, some ethnic minority men and a few women have traveled to work as hired labors in cities. This easily makes them slip to social evils, especially in the complex social context.

- Green bean is a food ingredient for dishes in traditional festivals and occasions of the local Tay and Nung people, and therefore the model implementation helps to preserve their unique cultural features.
- The model development lies in strategies to improve and diversify income as well as lessen pressure on the forest.

Environmental efficiency and sustainability

- Improve soil by using micro-organic fertilizer and microorganisms around the roots which can consolidate protein; use the plant stalk and leaves as fertilizer and release land in time for the cultivation of the next crop.
- Preserve *Vigna radiata* (L) gene of social and economic values.

Extension possibility

- The model has been extended by the residents in communes within the district and province that have similar soil conditions, however, mainly at scale to serve household consumption and the surplus amount, if any, is sold at local market.

APPLIED INDIGENOUS KNOWLEDGE

- Use indigenous variety of *Vigna radiata* (L) sp. which is resilient to pests and local long-lasting drought.
- The farmers grow green bean in Spring crop season since late March when bead-tree flower blossom (which means the soil is moist enough and the weather becomes warmer) to avoid having to repeat sowing and help the crop grow and develop quickly.

- Use ash to reduce pest prevention cost (sprinkle ash on leaves when detecting bugs). If there are *ban-mieu* insects, catch them and thread the caught ones and place in the middle of the field to repel others.
- Preserve seeds using ash, bead-tree leaves: Dried seeds will be put into glass jars/pots/bottles, then sprinkle a layer of ash or bead-tree leaves above and seal, which ensures prevention of mold and high sprouting rate in the following year. There are adjustments to suit and develop in local corresponding conditions.
- Bead-tree odor can repel insects.

CHALLENGES AND LESSONS LEARNED

Challenges

- Local authority and people still lack market information and production service-materials systems.
- The output market for agricultural products is still unstable.
- The people have limited technical capacity and thus fail to properly apply technical requirements in model design.

Lessons learned

- Supervised "hands-on" training method applied for people was a suitable approach.
- The criteria for the selection of participating households, implementation location should be clear and receive consensus from local people.
- Apply participatory approach, involve cadres at village, commune and district levels as well as core farmers in model implementation.
- The model implementation should focus on capacity building for the local people.
- There should be regular monitoring to detect households' mistakes and timely address them. Assign specific tasks to participants in the model and request participating households to give a pledge on model implementation.

(5). Model of raising black-bone chicken

Implemented by the Agriculture and Forestry Research & Development Center for Mountainous Region (ADC).

Project area: Mai Lap commune, Cho Moi district, Bac Kan province.

Scale: 800 chickens.

Breed: indigenous black-bone chicken of H'mong people.

Implementation time: 2018 - 2019.

Objective: use the indigenous breed that is resilient to local extreme weather condition, resistant to disease, yields tasty meat and suits the local households' economic conditions.

Picture 2.9: Model of raising indigenous black-bone chicken of H'mong people

EVALUATION ON THE MODEL'S EFFICIENCY

Efficiency in CC adaptation and rehabilitation

- H'mong black-bone chicken is resilient to extreme weather conditions in the Northern Mountain Region. They can be highly resistant to coldness and heat, rarely suffer diseases and do not require much caring, which is suitable to caring condition of local people.
- The livestock model follows biosafety requirements and helps improve product quality while reducing emission in livestock activity.

Economic efficiency and sustainability

- The model helps generate more income for participating households by offering more job and thus, lessens burden on women's shoulder.
- Raising indigenous black-bone chicken can take advantages of local maize, cassava, vegetable and banana as feed, reducing industrial feed by 50-80%.
- Net income from the model on the scale of 200 chickens is VND 22 million after 5 months, while raising hybrid chicken on the same scale only yields VND 16-18 million.
- There are market demands in many places for this chicken breed as it's not only a food but also valuable in traditional invigorating prescription.
- The model also helps to raise awareness of local people and authority of IK incorporation in modern sciences and techniques in production for better economic efficiency.

Institutional - social efficiency and sustainability

- The model implementation results have seen positive changes within the community.
- Both the authority and local people recognize the model success, especially in selling chicken for meat (the market price of black-bone chicken is higher than other breeds).
- The model helps create local jobs for ethnic minority women, contributing to the improvement of income and living conditions.
- Environmental efficiency and sustainability
- The model helps to preserve the valuable gene of H'mong black-bone chicken.

Extension possibility

There is a high possibility to extend the model. At the moment, H'mong people always maintain their livestock activity with this chicken breed

at household scale. Tay, Dao households are also involved in the model extension.

CHALLENGES AND LESSONS LEARNED

Challenges

At local level, there is a lack of information of market, breed, feed, causing the poultry raising activities quite limited. Therefore, the products are either bought by traders at low prices or stop at household scale as the people do not take initiation in seeking market for their products, leading to their orientation of small scale production for household consumption only.

Lessons learned

- There should be regular monitoring to detect households' mistakes and timely address them.
- Request participating households to give a pledge to make them more accountable during implementation course.

3.2. Agroecological models for climate change adaptation as researched and compiled in the Northern mountain region

3.2.1. Model of growing Dai Minh pomelo (Citrus maxima Merr sp.*)*

Objectives

Increase income by developing specialty fruit tree.

Summary of implementation results and applied indigenous knowledge

- The total area of Dai Minh pomelo in Yen Bai province in 2018 was about 200 ha.

- Adaptation:

The indigenous variety is highly resilient to weather, climate conditions, natural disasters and local disease as it has been grown and experienced natural selection for over 300 years. Dai Minh pomelo had an average yield of 17 - 18 tons of fruits/ha, 1.5 - 2 times as many as other pomelo varieties in the district.

- Economic efficiency: Upon fruit wrapping and foliar fertilizer application, Dai Minh pomelo's yield in 2018 was up by 1.5 times, reaching 25 tons/ha compared to 17 tons/ha in previous years. The weight per fruit was 0.8kg with thin skin, dry but juicy segments, charming taste and good appearance, which made them sold at a good price. Dai Minh pomelo helped to generate income of VND 611 million/ha and profit of VND 429 million/ha, in comparison with an average income of VND 300 million from other widely grown pomelo varieties.

- Social and institutional features: suitable with the community's culture and cultivation practices, accepted, maintained and developed by the community

- Environmental feature: helped to preserve the gene and promote the pomelo value.

- Extension possibility: Dai Minh pomelo has been extended to Doan Hung district, Phu Tho province. Yen Binh district, Yen Bai province has had a plan for the development of growing zones for Dai Minh pomelo on the total of over 450 ha, including 300 ha in Dai Minh and Han Da communes and others.

⇒ Highly adaptive to CC

- Applied indigenous knowledge:

+ Use of indigenous pomelo variety with more than 300-year history.

+ Tendering and thinning activities follow traditional experience passed on generation to generation.

Implementation time - location and implementing, cooperating agency

- Location: Dai Minh commune, Yen Binh district, Yen Bai province.

- Time: Dai Minh pomelo has been grown for more than 300 years.

- Implementation:

The farmers grew pomelo with technical assistance for fruit wrapping and forlia fertilizing application from Thai Nguyen University of Agriculture and Forestry.

3.2.2. Model of growing seedless persimmon (Diospyros sp.*)*

Objectives

Improve income and living conditions of ethnic minority people.

Summary of implementation results and applied indigenous knowledge

- Indigenous seedless persimmon was grown on the total area of 689 ha in Bac Kan province in 2018, mainly in Ba Be, Cho Don and Ngan Son district. The harvested area was 495 ha, with total production of 2,123 tons.

- Adaptation: the indigenous seedless persimmon is highly adaptive to local climate, weather conditions, natural disasters and diseases. It could be resilient in dry and cold weather. Growing seedless persimmon has reduced the community's risk of being affected by CC changes.

- Economic features: the persimmon selling price at garden was VND 20,000/kg, making up more than VND 80 million of net income per ha, which was 3-5 times as high as that of rice. Seedless persimmon is a staple plant in the local socio-economic development strategy. Fruit is harvested before and during Mid-Autumn festival, which results in stable consumption and selling price.

- Social and institutional features: suitable with the community's culture and cultivation practices, accepted, maintained and developed by the community

- Environmental feature: helped to preserve the valuable gene.

- Extension: Seedless persimmon is grown dispersedly in Ba Be, Cho Don and Ngan Son districts which have particular climate and soil conditions.

Thanks to the maintenance of local variety for nearly 100 years with secured quality, Bac Kan seedless persimmon was granted with a geographical indication registration certificate in 2010. Another honor came in 2013 when Bac Kan seedless persimmon was listed in top 100 brands of Vietnam by Vietnam Intellectual Property Association in coordination with The Intellectual Property and Creativity Magazine.

⇒ Highly adaptive to CC

- Applied indigenous knowledge:

+ Use of indigenous persimmon variety.

+ Harvesting with a tool made of bamboo to avoid rushing the fruit.

+ Technique of eliminating acrid taste follow Tay people's experience using water for 2-3 days.

Implementation time - location and implementing, cooperating agency

Location: Cho Don, Ba Be and Ngan Son districts, Bac Kan province.

- Time: seedless persimmon has been grown for more than 60 years.

- Implementation:

The farmers grew persimmon with technical assistance from province's and districts' specialized departments.

3.2.3. Model of growing Bac Kan mandarin orange (Citrus reticulata sp.)

Objectives

Improve income and living conditions of ethnic minority people.

Summary of implementation results and applied indigenous knowledge

- The total area of Bac Kan indigenous mandarin orange in 2018 was 2832 ha.

- Adaptation: The indigenous mandarin orange is highly adaptive to local climate, weather conditions, less affected by diseases than other orange varieties.

- Economic feature: Reduced cost for pesticide by 30%, the indigenous mandarin orange model generated net income of VND 30-40 million/ha. In 2015, Bac Kan mandarin orange was awarded "Vietnam agricultural golden product".

- Social and institutional features: suitable with the community's culture and cultivation practices, accepted, maintained and developed by the community.

- Environmental feature: helped to preserve the valuable gene.

- Extension: The model was initially implemented in Quang Thuan commune, Cho Don district and then extended to neighboring districts of Cho Moi, Ba Be and Bach Thong with a total area of nearly 3000 ha.

Bac Kan province has been granted with a geographical indicator registration certificate for farmers.

⇒ Highly adaptive to CC

- Applied indigenous knowledge: Used indigenous mandarin orange variety.

Implementation time - venue and implementing, cooperating units

- Location: Cho Don, district, Bac Kan province.

- Time: Bac Kan mandarin orange has been grown for more than 100 years

- Implementation:

The farmers grew mandarin orange with technical assistance from province and districts' specialized departments.

3.2.4. Model of preserving and maintaining Khau Nua Lech rice (Oryza sativa)

Objectives

Revigorate Lech sticky rice variety (*Oryza sativa*) and extend cultivation area in Bao Ai commune, contribute to improvement of households' economic status while preserving and developing indigenous rice variety and strengthen capacity to cultivate rice in CC context.

Summary of implementation results and applied indigenous knowledge

- 30 Nung farmers attending initial training using the Farmer Field Schools (FFS) method during 2013 autumn crop season were selected to maintain research on how to revigorate the rice variety and SRI to form the group of farmers as community trainers.

- Adaptation: Rice plants had firmer stalk, valuable characteristics such as pest resistance, drought resilience and tasty rice restored.

- Economic feature: Reduce the amount of seedling by 40-70%, chemical fertilizer by 30%, a third of times of pesticide application compared to previous seasons.

- Social features: The community's awareness was raised and women were more confident to participate in public activities, promoting operations of organizations, women's union and farmers' union.

⇒ Highly adaptive to CC

- Applied indigenous knowledge:

+ Maintain and use the indigenous rice variety.

+ Apply the method of drying seedling by placing on smoking shelf for seed protection and worm-borer prevention.

Implementation time - location and implementing, cooperating agency

- Location: Thai Binh and Bao Ai communes, Yen Binh district, Yen Bai province.

- Time: from 2013 - 2015.

- Implemented by: SRD in coordination with local plant protection divisions, Yen Bai province's plant protection department, and Field Crops Research Institute.

3.2.5. Model of supporting local people to grow and preserve indigenous medicinal plants in Yen Binh district, Yen Bai province

Objectives

To generate more income for households by growing and developing indigenous herbal and medicinal plants in commercial manner, and

thereby preserve the medicinal plants and promote treatment using local herbal medicinal plants.

Summary of implementation results and applied indigenous knowledge

- 256 households participated and grew 30,000 m^2 of herbal and medicinal plants; the community had a better awareness of medicinal plants and forest preservation

- Adaptation: Increased the medicinal plant's resilience to increased temperature, drought and dangerous cold waves

- Economic feature: Reduced natural disaster risks and ensured income for farmers, increased the yield and income in a more sustainable manner compared with other occupations

- Environmental feature: Lessened pressure of natural forest trees, contributed to the preservation of valuable gene, sustainable management and protection of forest resources and maintenance of the regional biodiversity.

$\Rightarrow$ Moderately adaptive

- Applied indigenous knowledge:

+ Use the local indigenous herbal and medicinal plants.

+ Apply methods of planting and preserving the medicinal plants under forest canopy.

Implementation time - location and implementing, cooperating agency

- Location: Cam An and Bao Ai communes, Yen Binh district, Yen Bai province.

- Time: from 2013 - 2015.

- Implemented by: SRD in coordination Yen Bai Province's Association of Oriental Medicines.

3.2.6. Model of value chain for Nam Det organic cinnamon (Cinnamomum verum)

Objectives

Increase women's economic role by participating in development of organic cinnamon value chain.

Summary of implementation results and applied indigenous knowledge

- The total cinnamon area in Lao Cai province is 23,448ha, in which the total area in Nam Det commune is over 1,700 ha, including 500 ha of cinnamon forest certified to be organic cinnamon.

- Adaptation:

Cinnamon is an indigenous plant grown under organic standards and therefore, is highly adaptive to external conditions, natural disaster and disease.

- Economic feature: Reduce natural disaster risks and ensure income for farmers, increased their income (the price per kg of organic cinnamon is VND 2000 higher than that of ordinary cinnamon) in a more sustainable manner compared with other occupations. The income from cinnamon is estimated to add more than VND 20 billion/year to the local economy

- Institutional and social features: create local jobs for the people, including men and women

- Environmental feature: Lessen pressure of natural forest exploitation, contribute to the preservation of valuable gene, sustainable management and protection of forest, land and water resources and maintenance of the regional biodiversity

⇒ Highly adaptive to CC

- Applied indigenous knowledge:

+ Use indigenous variety.

+ Apply organic farming methods.

+ Intercrop with short term crops during first 1-2 years to diversify livelihood.

Implementation time - location and implementing, cooperating agency

- Location: Nam Det commune, Bac Ha, Lao Cai.

- Time: from 2016 - 2020.

- Implemented by: SNV in coordination with Lao Cai Province's Department of Agriculture and Rural Development.

3.2.7. Model of raising indigenous black pig

Objectives

Improve ethnic minority women's livelihood, increase their resilience to environmental changes.

Summary of implementation results and applied indigenous knowledge

- Indigenous black pig raised from 2018 accounted for more than 50% of the total pig herd in Xuan Lac and Nam Cuong commune, Cho Don district

- Adaptation: Highly adaptive to environmental conditions and less affected by diseases

- Economic feature: The selling price of black pig is VND 10,000/kg higher than that of white pig. Local vegetable, grass, banana, maize and cassava could be used as feed, which helps reduce the cost for industrial feeds by 80-100%, for preventive and treatment medicines by 50%

- Institutional and social features: requires low investment cost and suitable for poor people, suitable with the cuisine using black pork in the communities of Mong, Dao, Tay people.

$\Rightarrow$ Highly adaptive to CC

- Applied indigenous knowledge:

+ Use indigenous black pig breed.

+ Use local by-products and feed.

Implementation time - location and implementing, cooperating agency

- Location: Cho Don, Bac Kan.

- Time: Indigenous black pig has been raised locally for more than 100 years.

- Implemented by: implemented and developed by the local people.

3.2.8. Model of self-sufficient agriculture production with no waste in Phu Luong, Thai Nguyen (raise Perionyx excavates - poultry, plant bonsai, drip irrigation)

Objectives

Improve livelihood and sustainably protect protection forest.

Summary of implementation results and applied indigenous knowledge

- Key outcomes: Increased income of households, increased land use efficiency, strengthened natural disaster response capacity and fostered cooperation and participation of stakeholders.

- Economic features: Use of (*Perionyx excavates*) helped save input costs while increasing output value, increased economic efficiency by 10-20%, saved costs for industrial feed, for preventive and treatment medicines in poultry raising by 50%

- Institutional and social feature: suitable with the community's culture, accepted and applied by the community

- Environmental feature: Improved the human health, environment and landscape around the households thanks to the reduction in pollution caused by waste and waste water

=> Highly adaptive to CC

- Applied indigenous knowledge:

+ Applied self-sufficient model with no waste, raised *Perionyx excavates* as feed for chicken and organic fertilizer for crop production and bonsai plantation.

Implementation time - location and implementing, cooperating agency

- Location: On Luong, Yen Lac, Dong Dat communes, Thai Nguyen province.

- Time: from 2012 - 2015.

- Implemented by: SRD in coordination with People's Committee of Phu Luong district, Thai Nguyen province.

3.2.9. Model of preserving and promoting indigenous plant (Docynia indica Dec.*) in ethnic minority area in Yen Bai province*

Objectives

Preserve indigenous medicinal varieties, supply medicinal materials, diversify livelihood for ethnic minority people, cover bare hills with trees, and mitigate disaster risk due to local erosion, flash-floor and landslide.

Summary of implementation results and applied indigenous knowledge

- 50 households were provided with seedlings and fertilizer for their growing of 500-1000m^2 of *Docynia indica* Dec., which was then extended to neighboring communes.

- Adaptation: Increased forest coverage on uncultivated hills and mountains which used to be overexploited, contributed to enrichment afforestation, prevented soil erosion, mitigate disaster risk and strengthened the community's response capacity.

- Economic feature: Increased households' income from their traditional cultivation land area (up by 30% compared with rice, maize cultivation).

- Social, institutional features: Created more jobs and made ethnic minority women, especially the poor ones more confident and active.

- Environmental feature: Supported land and flora resource protection, restored indigenous plants, restored ecosystem, enriched the forest and retained underground water source.

$\Rightarrow$ Moderate adaptation

- Applied indigenous knowledge:

+ Used indigenous *Docynia indica* variety.

+ Used traditional methods in collecting and harvesting activities.

Implementation time - location and implementing, cooperating agency

- Location: Nam Khat commune, Mu Cang Chai district, Yen Bai province.

- Time: from 2013 - 2015.

- Implemented by: Yen Bai's Center for Science-Technology Development and Community Health Care.

REFERENCE

1. Abate, R.S., & Kronk, E.A., 2013. Climate Change and Indigenous Peoples: The Search for Legal Remedies. Edward Elgar Publishing, Cheltenham.
2. Adamo, A. et al. 1998. Gender and Biodiversity Research Guidelines. Sustainable Use of Biodiversity Program, IDRC, Ottawa, Canada.
3. ADC, 2014. Tài liệu "Hướng dẫn xác định và sử dụng kiến thức bản địa trong thích ứng với biến đổi khí hậu dựa vào cộng đồng". Trung tâm Nghiên cứu phát triển nông lâm nghiệp miền núi (ADC), CARE Vietnam.
4. ADC. 2013. Kiến thức bản địa thích ứng với biến đổi khí hậu. Báo cáo nghiên cứu.
5. Alexander, C., N. Bynum, E. Johnson, U. King, T. Mustonen, P. Neofotis, N. Oettlé, C. Rosenzweig, C. Sakakibara, V. Shadrin, M. Vicarelli, J. Waterhouse, and B. Weeks, 2011. Linking indigenous and scientific knowledge of climate change. Bioscience, 61, no. 6, 477-484, doi:10.1525/bio.2011.61.6.10.
6. AliSEA, 2018. Agroecology Futures, Inspiring and innovating stories from the Agroecology Learning Alliance in South East Asia, retrieved from https://ali-sea.org/aliseaonlinelibrary-dashboard/get/file/Agroecology-Futures-Inspiring-and-innovating-stories-from-the-Agroecology-Learning-Alliance-in-South-East-Asia.pdf
7. Altieri M.,2005. Agroecology: principles and strategies for designing sustainable farming systems, University of California, Berkeley.
8. Bộ Tài Nguyên và Môi trường, 2016. Kịch bản BĐKH và nước biển dâng cho Việt Nam. Nhà xuất bản Tài nguyên môi trường và Bản đồ Việt Nam, Hà Nội.

9. BCĐ TW PCTT (Ban Chỉ đạo Trung ương về Phòng chống thiên tai). 2017. Báo cáo Tổng kết công tác phòng chống thiên tai năm 2016 triển khai nhiệm vụ năm 2017. http://phongchongthientai.vn/tin- tuc/chu-dong-ung-pho-truoc-khi-thien-tai-xay-ra/-c4399.html

10. Berkes F, Colding J, Folke C., 2000. Rediscovery of traditional ecological knowledge as adaptive management. Ecological Applications (10 (5): 1251-1262.

11. Berkes F, Colding J, Folke C., 2000. Rediscovery of traditional ecological knowledge as adaptive management. Ecological Applications (10 (5): 1251-1262.

12. CARE Vietnam, 2010. Ethnic minorities in Northern mountain of Vietnam: vulnerability and capacity to adapt to effects of climate change.

13. CARE Vietnam, 2013. Climate vulnerability and capacity of ethnic minorities in Vietnam. http://careclimatechange.org/publications/cv-ca-ethnic-vietnam/

14. Chambers, P. 1994. Participatory Rural Appraisal (PRA): Analysis of Experience. World Development, vol.22, no. 9, pp. 1253-1268

15. Cochran, Patricia; Huntington, Orville; Pungowiyi; Caleb, Tom, Stanley; Chapin III, F Stuart; Huntington, Henry; Maynard, Nancy; Trainor, Sarah., 2013. Indigenous frameworks for observing and responding to climate change in Alaska

16. Dasgupta, Susmita and Laplante, Benoit and Meisner, Craig M. and Wheeler, David and Jianping Yan, Da- vid. 2007. The Impact of Sea Level Rise on Developing Countries: A Comparative Analysis. World Bank Policy Research Working Paper No. 4136.

17. Davis, S. H. & Ebbe, K. 1993. Traditional knowledge and sustainable development. Proceedings of a conference sponsored by the World Bank Environment Department and the World Bank Task Force on the International Year of the World's Indigenous People held at the World Bank, Washington, D. C., September 27-28, 1993/ Shelton H. Davis, Katrinka Ebbe, (eds); Alicia Hetzner, editorial consultant. Washington, D. C: World Bank.

18. Emery, A.R. 1996. The Participation of Indigenous Peoples and Their Knowledge in Environmental Assessment and Development Planning (draft). Centre for Traditional Knowledge: Ottawa, Canada.

19. FAO, 2018. The 10 elements of agroecology: guiding the transition to sustainable food and agricultural systems. Food and Agriculture Organisation, Rome. http://www.fao.org/3/i9037en/i9037en.pdf

20. FAO. 2011. Climate Change Impacts on Agriculture in Vietnam: Strengthening Capacities to Enhance Coordinated and Integrated Disaster Risk Reduction Actions and Adaptation to Climate Change in Agriculture in the Northern Mountain Regions of Viet Nam. Retrieved 14 Aug. 2017, from http://www. fao.org/climatechange/34068-0d42acdf5fb- 7c4d80f3013c038ab92ce6.pdf

21. Ford, J., Smit, B., 2004. A framework for assessing the vulnerability of communities in the Canadian Arctic to risks associated with climate change, Artic, 57: 389-400.

22. Forsyth, T. 2017. Community-Based Adaptation to Climate Change. Oxford Research Encyclopedia of Climate Science. Retrieved 14 Aug. 2017, from http:// climatescience.oxfordre.com/view/10.1093/acrefore/9780190228620.001.0001/acre- fore-9780190228620-e-602.

23. Glen Kelly, 2005. Threats to the Practice and Transmission of Traditional Knowledge, Regional Report: Asia and Australia, Phase II of the Composite Report on the Status and Trends Regarding the Knowledge, Innovation and Practices of Indigenous Peoples and Local Communities relevant to the Conservation and Sustainable Use of Biodiversity, UN Doc: UNEP/CBDWG$_8$J/4/INF/4, p 25.

24. Gliessman S., 2016. Transforming food system with agroecology. Agroecology and sustainable food systems, 40 (3): 187-189.

25. Gómez-Baggethun E, Reyes-García V. 2013. Reinterpreting change in traditional ecological knowledge. Human Ecology, 41:643–647. http://dx.doi.org/10.1007/s10745-013-9577-9.

26. Gómez-Baggethun, E., E. Corbera, and V. Reyes-García. 2013. Traditional ecological knowledge and global environmental change:

research findings and policy implications. Ecology and Society 18(4): 72. http://dx.doi.org/10.5751/ES-06288-180472

27. Grenier, L. 1998. Working with Indigenous Knowledge: A Guide for Researchers. IDRC: Ottawa, Canada.

28. Grossman, Z., & Parker, A., 2012. Asserting Native Resilience: Pacific Rim Indigenous Nations Face the Climate Crisis. Oregon State University Press, Corvallis, Oregon.

29. Huffman, M. R. 2013. "The Many Elements of Traditional Fire Knowledge: Synthesis, Classification, and Aids to Cross-Cultural Problem Solving in Fire-Dependent Systems Around the World," Ecology and Society 18 (4): 3.

30. IIRR, 1996. Recording and using indigenous knowledge: a manual. International Institute of Rural Reconstruction (IIRR), Cavite, Philippines. 211 pp.

31. IPCC, 2007: Climate Change 2007: The Scientific Basis, Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

32. IPCC, 2013. Climate change 2013. The physical science basics. The Contribution of Working Groups I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change.

33. IPCC, 2014: Annex II: Glossary [Mach, K.J., S. Planton and C. von Stechow (eds.)]. In: Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, R.K. Pachauri and L.A. Meyer (eds.)]. IPCC, Geneva, Switzerland, pp. 117-130.

34. ISE 1995. Guidelines for research, collections, databases and publications. International Society for Ethnobiology (ISE). Unpublished report.

35. Johnson, M. 1992. Lore: Capturing Traditional Environmental Knowledge. Ottawa: Dene Cultural Institute/IDRC.

36. Mai Thanh Sơn và cộng sự. 2007. Dự án "Bước đầu tổng kết các phương pháp phát triển và tìm kiếm các cơ chế nhằm nâng cao tiếng nói của cộng đồng dân tộc thiểu số trong quá trình ra quyết định". Báo cáo phân tích tài liệu thứ cấp, Hà Nội.

37. Maldonado, J.K., Pandya, R.E. & Colombi, B.J. (eds.), 2013. Climate change and indigenous peoples in the United States: impacts, experiences and actions. Climatic Change (special issue).

38. Mason, L., G. White, G. Morishima, E. Alvarado, L. Andrew, et al. 2012. "Listening and Learning from Traditional Knowledge and Western Science: A Dialogue on Contemporary Challenges of Forest Health and Wildfire," Journal of Forestry 110 (4):187-193.

39. Matowanyika, J. 1994. "What are the issues on indigenous knowledge systems in southern Africa?" In Indigenous Knowledge Systems and Natural Resource Management in Southern Africa. Report of the Southern Africa Regional Workshop, Harare, Zimbabwe, 20-22 April 1994. IUCN-ROSA: Zimbabwe.

40. McSweeney, C., New, M., and Lizcano, G. 2010. UNDP Climate Change Country Profile: Vietnam. Retrieved 14 Aug 2017, from http://www.wpro.who. int/environmental_health/documents/docs/VT- N_01BD.pdf?ua=1.

41. Naess, L. O., 2013. The role of local knowledge in adaptation to climate change. WIREs Clim Change, 4: 99–106

42. Narayan, D. 1996. What is Participatory Research? In Toward Participatory Research. D. Narayan. Washington, D.C. World Bank. p. 17-30. Reprinted with permission from the World Bank.

43. Nhóm công tác biến đổi khí hậu (CCWG). 2011. Biến đổi khí hậu: Tác động, khả năng ứng phó và chính sách.

44. Nyong, A., Adesina, F., and Elasha, B, O., 2007. The value of indigenous knowledge in climate change mitigation and adaptation strategies in the African Sahel. Mitigation and Adaptation Strategies for Global change, 12:787–797.

45. Pareek, A. and Trivedi, P.C. (2011). Cultural values and indigenous knowledge of climate change and disaster prediction in Rajasthan, India, Indian Journal of Indigenous Knowledge, 10(1): 183-189

46. Parrotta, J.A.; Agnoletti, M. 2012. Chapter 13: traditional forest-related knowledge and climate change. In: Parrotta, J.A.; Trosper, R.L., eds. Traditional forest-related knowledge: sustaining communities, ecosystems and biocultural diversity. Dordrecht, The Netherlands: Springer: 491–534.

47. Pfeiffer JM, Butz RJ. 2005. Assessing cultural and ecological variation in ethnobiological research: the importance of gender. J Ethnobiol. 25:240–278.

48. Quiroz, C. 1994. Biodiversity, indigenous knowledge, gender and intellectual property rights. Indigenous Knowledge and Development Monitor 2 (3)

49. Rathgeber, Eva. 1997. "Gender analysis: What are we looking for?" In Management of Water Demand in Africa and the Middle East: Current Practices and Future Needs, David B. Brooks, Eglal Rached, and Maurice Saade (editors). IDRC: Ottawa, Canada

50. Riedlinger, D. & Berkes, F., 2001. Contributions of traditional knowledge to understanding climate change in the Canadian Arctic. Polar Record, 37, pp. 315-328 doi:10.1017/$S_{0032247400017058}$

51. Simpson, B. 1994. "Gender and the social differentiation of knowledge." Indigenous Knowledge and Development Monitor 2 (3).

52. Stassart PM Baret P, Grégoire JC, Hance T, Mormont M, Reheul D, Vanloqueren G, Visser M, 2012. Trajectoire et potentiel de l'agroécologie, pour une transition vers des systèmes alimentaires durables. In: Van Dam D, Streith M, Nizet J, Stassart P.M (dir.) Agroécologie. Entre pratiques et sciences sociales. Educagri éditions, 2012, Paris, pp. 25–51

53. Thrupp, L.A. 1989. Legitimizing Local Knowledge: From Displacement to Empowerment for Third World People. Agriculture and Human Values. Summer Issue. Pp.13-24. Reprinted with permission from Kluwer Academic Publishers.

54. Nguyễn Văn Thắng và cs, 2010. Biến đổi khí hậu và tác động ở Việt Nam. Viện Khoa học Khí tượng thuỷ văn và Môi trường, Hà Nội.

55. Vũ Văn Liết, Vũ Thị Bích Hạnh, Phan Đức Thịnh, Nguyễn Văn Hà, Nhâm Xuân Tùng, Nguyễn Thị Hảo, Phạm Mỹ Linh, Đàm Văn Hưng, Vũ Quốc Đại, Nguyễn Bằng Tuyên, Phạm Quang Tuân. 2011. Nghiên cứu về kiến thức bản địa trong lĩnh vực quản lý tài nguyên thiên nhiên thuộc lĩnh vực nông nghiệp của một số cộng đồng dân tộc thiểu số miền núi phía bắc. Báo cáo nghiên cứu. CARE Vietnam.

56. Warren, D. M. 1991. Using Indigenous Knowledge in Agricultural Development. Discussion Paper 127. Washington D.C.: World Bank.

57. Wezel, A. Bellon S., Dore, T., Francis D. 2009. Agroecology as a science, a movement and a practice. A review, Agronomy for Sustainable Development.

58. Wickham, T.W. 1993. Farmers ain't no fls: exploring the role of participatory rural appraisal to access indigenous knowledge and enhance sustainable development research and planning. A case study of Dusun Pausan, Bali, Indonesia.

59. Williams, T.; Hardison, P., 2013. Culture, law, risk and governance: Contexts of traditional knowledge in climate change adaptation. Climatic Change 120(3): 531-544

60. WIPO. 2012. The Protection of Traditional Knowledge: Draft Articles. Retrieved 14 Aug 2017, from http:// www.wipo.int/edocs/mdocs/IK/en/wipo_grikf_ ic_21/wipo_grikf_ic_21_4.pdf

61. World Bank. 1998. Indigenous knowledge for development: a framework for action. Washington, DC: World Bank. http://documents.worldbank. org/curated/en/388381468741607213/Indigenous-knowledge-for-development-a-framework-for-action

62. Zhai, F., and J. Zhuang. 2009. Agricultural Impact of Climate Change: A General Equilibrium Analysis with Special Reference to Southeast Asia. ADBI Working Paper 131. Tokyo: Asian Development Bank Institute.

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