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Indigenous Farmers' Responses to Climate Change on the Bui Plateau of Cameroon

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Abstract

African farming societies have always survived changing environmental shocks. Enhancing indigenous capacity is key to effective participation in the development process in the era of global climate change. Inadequate information flow between farmers and weather scientists has brought ethno-meteorological knowledge to the limelight for climate change adaptation in rural areas. This study assesses indigenous farmers' responses to climate change on the Bui Plateau. Data sources included field observations and questionnaires (N=597) in the seven agroecological basins of the Bui Plateau. Results showed that farmers make informed decisions on cropping cycles based on the behaviour of plants and animals, consultation of local weather seers, and community leaders and the behaviour of streams. Traditional responses may not adequately address climate change uncertainties, but they can lead to sustainable responses in the longer term. Instead of using indigenous knowledge solely or neglecting it, its integration into climate change policies can lead to cost-effective adaptation. Indigenous knowledge delivers appropriate entry points for climate change adaptation.

Keywords: Adaptation; Culture; Environment; Ethno-Meteorology; Indigenous Knowledge

Introduction

Climate variability and change compromise the ability of rural farmers to satisfy needs inherent to the environment [1]. Although environmental changes have occurred over generations, rural farmers have adapted using local knowledge [2]. Indigenous knowledge is a readily available climate-smart tool for sustainable development and the management of climate variability [3]. Environmental problems vary over space and time [4], but rural farmers, through continued trial and error, and sustained interactions with the local environment, have developed a wealth of knowledge about nature in their *locale* that they use in coping with and solving their climate-related problems [5].

'Indigenous knowledge' (IK) is often used to describe the ideas developed by a community as opposed to the scientific or *'modern knowledge'* [6,7]. It is the basis for local-level decision-making in many rural communities [8]. It is valuable for the culture and scientists and planners striving to improve the well-being of rural areas [9]. Incorporating IK into climate change policies can lead to cost-effective, participatory and sustainable adaptation [10]. IK, a complex and cumulative body of facts, practices and representations, is preserved and advanced by people with prolonged histories of connections with the natural environment [11]. These systems are complex and include attachment to place, language, perception of worldview and spirituality [12].

Knowledge, practices and innovations of indigenous and local communities worldwide are rooted in experience and history [13]. IK is dynamic and adapts to environmental and cultural change, incorporating other perspectives and forms of knowledge [14]. IK is transmitted orally from generation to generation [11]. Local communities in Sub-Saharan Africa have developed intricate systems of gathering, predicting, interpreting and decision-making about the weather [15]. Farmers use knowledge of weather systems such as rainfall, thunderstorms, windstorms, harmattan and sunshine to prepare for future activities [16]. Elderly farmers frame propositions about seasonal rainfall by observing natural phenomena, while ritual and cultural specialists draw forecasts from predictions, and visions [17]. The most reliable indicators are the intensity, timing and duration of low temperatures during the beginning of the dry season [7]. Other forecasting indicators include the timing of fruiting of certain local trees, the water level in ponds and streams, the nesting and migratory patterns of birds and insect behaviour in waste heaps [9].

Sub-Saharan African cultures encompass an informal institution of *'rainmakers'* who would not as much invoke rains, but predict them based on *ethnic meteorology* (an indigenous way of forecasting and interpreting weather conditions) [18,8]. Globalisation has eroded the knowledge system of community people to the extent that these local curators are branded as *'backward charlatans'* [12]. Apart from the stigmatisation and labelling experienced by small farmers, abrupt changes in weather patterns, which also interrupt natural indicators used in ethno-meteorology, continue to overwhelm the smallholders in their present environments [19]. More than ever before, smallholders are now consistently susceptible, making them more socio-economically miserable [20]. Regardless of the current influx of scientific weather forecasts, smallholder farmers are deeply entangled in the complexities of climate variability and climate change [18]. In the phase of these mounting environmental crises, this study aims to assess indigenous farmers' responses to climate change on the Bui Plateau.

Study Area and Methodology

The Bui Plateau of the Bamenda Highlands of Cameroon has seven micro agro-ecological zones situated between latitudes 6°00"-6°20″N and longitudes 10°30″-10°60″E (Figure 1). Bui is an orographic plateau within the Cameroon Volcanic Line (CVL) with spectacular landscapes like Mount Oku (3,011 masl) and the Mbaw–Tikar Plains (≈710 masl). It provides a major watershed for the Niger and Sanaga river systems (Tume and Fogwe, 2018). The area has a surface area of about 2,795 km^2. Administratively, this area covers Bui Division, with headquarters in Kumbo, covering six administrative units: Kumbo (630 km^2), Jakiri (675 km^2), Nkum (375.3 km^2), Nkor–Noni (307.7 km^2), Mbiame (575 km^2) and Oku (232 km^2).

The Bui Plateau is diverse and segmented into seven agrarian basins, which do not respect administrative boundaries, necessitating the administration of questionnaires in clusters. The principle of cluster sampling solves the problem of data collection in a culturally and physically diverse area. A convenient way to take a sample is to divide the area into smaller overlapping areas and then randomly select some smaller areas (households located in the agroecological basins). In cluster sampling over the Bui Plateau, the target population were rural farmers.

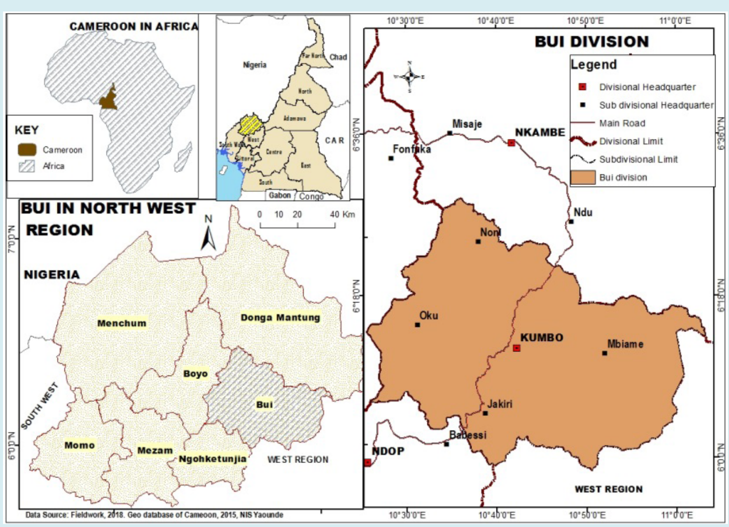

Figure 1: Location of the Bui Plateau.

These were subdivided into relatively smaller units relating to crops which are grown in specific areas. In cases where more than one crop dominates in an agro-basin, double or multiple levels of clustering were applied (multi-stage cluster sampling). A total of 597 questionnaires were administered (Table 2).

Administrative units	*Population*		*Agro basins*	*Questionnaires*	
	Population	*%*		*F*	*%*
Kumbo	*127,919*	22.35	Nkar-Kumbo-Kikaikom	94	15.7
Jakiri	*59,951*	10.47	Mbokam-Ngomrin-Mbaw Nso	68	11.4
Nkum	*127,538*	22.28	Dzeng-Tatum-Banten	91	15.2
Nkor-Noni	*63,487*	11.09	Djottin-Nkor-Lassin	81	13.6
Elak-Oku	*144,800*	25.30	Oku-Vekovi-Tadu	105	17.6
Mbiame	*48,684*	8.51	Mbiame-Nkuv-Ndzeen	158	26.4
Total	*572,379*	*100*	*Total*	*597*	*100*

Table 2: Population of the Bui Plateau and administration of questionnaires.

The Nkar-Kumbo-Kikaikom agro basin covers most villages in Kumbo Central, Dzekwa area, the middle belt of Jakiri Sub-Division, extending down to Wainanmah. The Ngomrin-Mbokam-Mbaw Nso Plain covers the southeastern part of the Jakiri Sub-Division, extending northeast into the Mbiame Sub-Division and thrusting eastwards into the Ndop and Tikar plains. Oku-Vekovi-Tadu basin covers the highland montane communities of Jakiri Sub-Division like Kinsenjam and Vekovi, extending across to Kaiy, Taashem and Vivem in Kumbo Central Sub-Division. It extends westward to cover all of the Oku Sub-Division. The Dzeng-Tatum-Banten basin covers much of the Nkum Sub-Division. It extends north-westward into the Noni Sub-Division. From the Dzeng Plateau, it shares boundaries with Mbiame and covers the rugged terrane of Yangkitari, which is a northern extension of the Kov Ndzeen range in Kumbo Central Sub-Division. Nkuv-Ndzeen basin covers the southeastern part of Kumbo Central. It is a rugged frontier, which is reputed for massive deforestation, overgrazing, cropper-herder conflicts, landslides and fast-flowing streams. The Djottin-Nkor-Lassin Plain is located at the northwest edge of the Plateau. It extends northwards into the Donga plain. The Mbiame basin is situated between the Mbaw Nso Plain and Dzeng. It can be described as a transitional ecological zone because of a mixture of highland and lowland climatic characteristics.

Results

The dearth of meteorological data in the Bamenda Highlands necessitates the use of indigenous perceptions. The indicators include sources of weather activities and local weather information, farmers' knowledge of weather forecasting, farmers' perception of the nature of local and scientific weather knowledge, perception of climate variability, and perception of factors influencing indigenous environmental knowledge and practices. It is assumed that indigenous knowledge is a more dependable source of weather and environmental knowledge than conventional sources on the Bui Plateau.

Sources of Indigenous weather knowledge

Sources of Indigenous weather activities on the Bui Plateau are through the behaviour of some plants (49.4%), personal intuitive perception (18.9%), the behaviour of some animals (12.7%), consultation of traditional weather seers (4.7%), the behaviour of streams (6%) and consultation of community elders (3.7%). A small proportion of inhabitants of the population of the Bui Plateau uses conventional sources such as television, (0.8%), meteorological services (1.7%), and radio (1.5%) (0.5%) (Figure 2). The dominance of indigenous sources of weather activities is because most farming communities do not have access to electricity, which deprives them of gadgets like televisions and other electronic devices.

Farmers in frontier basins like Lassin, Mbaw Nso, Nkuv, Gwarkang, Mbokam and Njanawa use mainly simple phones (for those who can afford them) charged with small solar panels. This is partly why such farmers resort more to indigenous sources of weather activities than scientific weather information. Indigenous farmers reported about 47% that the language of conventional weather forecasting is too complex and hard for them to understand. They also asserted that the situation is worsened by the absence of weather scientists (37%) to inform them about weather variations for agricultural planning. Rural farmers also asserted that scientific weather is faulty (9%) and hardly correspond to observed realities and it is communicated sporadically through local radio and television channels

(7%). With these limitations of conventional weather sources, farmers rely on community elders (45%), personal weather observation (27%), local weather seers (24%), friends and other farmers (3%).

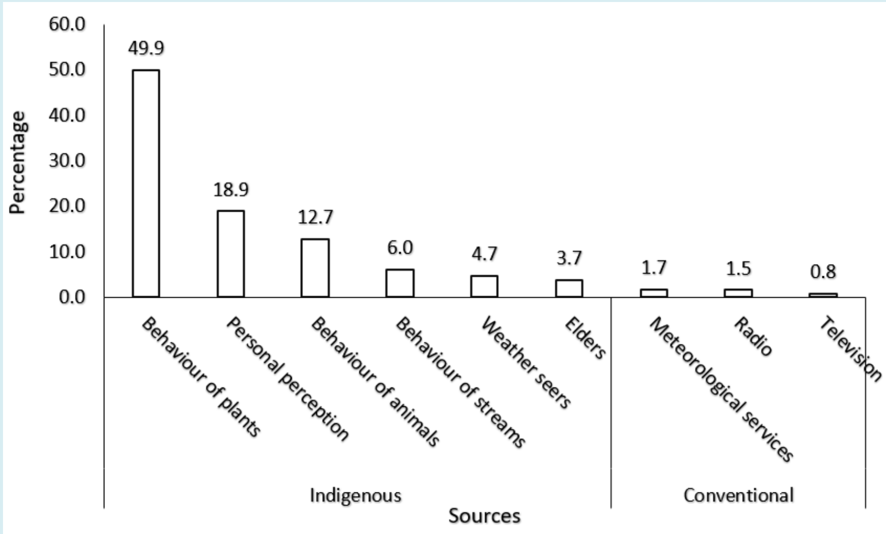

Figure 2: Sources of weather knowledge of the Bui Plateau.

Local weather seers and community elders often invoke the *gods of the rain* through periodical incantations and traditional sacrifices. In Nso land for example, such traditional sacrifices are performed at the beginning of the planting season, where the *'gods'* are invoked for a good growing season, before the first weeding, harvesting and farming season. The first sacrifices are performed by the *Fon* (King) of Nso at five shrines: the palace in Kumbo, Mantum (Jakiri), Kinsaan plunge pool (Kitiwum), Mairin plunge pool (Takui) and the palace in Kovifem. After the fon's performance, other traditional leaders do the same in their respective areas of authority. Such sacrifices involve pouring libation, invocations and slaughtering goats and chickens, where their blood is sprinkled as a sacrifice. The slaughtered animals are not edible by anyone. Their carcasses are allowed in the open to be devoured by vultures and other animals.

Community knowledge for agrarian weather forecasting

Community knowledge of weather forecasting is an important component of *ethno-meteorology*. It is based on traditional ecological knowledge handed down from generation to generation. Several indicators were used in this study to express indigenous community knowledge for planning agricultural activities (Table 2).

Indicators	%
Discerning whether there will be excess or scarce rains in a given farming year	41.9
Forefathers from whom the farming experience was acquired	70.7
Build of rain clouds	95.5
Mere smells	51.4
Necessary decisions to overcome any weather problems	51.3
Personal experience	72.2
Predicting extreme temperatures in a given farming year	55.9
Sounds of birds and insects	73.7
Star constellation, predict whether it will rain or not	60
The pattern of early rains in a farming year	55.6
The sequence of yearly weather events in a farming season	42.9
Through certain plants	49.6

Table 2: Farmer's knowledge of weather forecasting on the Bui Plateau.

This is because conventional weather services are relatively absent, with only three functional stations (as of 2023) (Takui, Shisong, Jakiri). With increasing uncertainty of first rains, most decisions made by indigenous farmers on the Bui Plateau are based on personal experience and conviction (72.2%). As risky as such decisions at the beginning of the planting may be, farmers perceive that the behaviour of rains at the onset of the wet season gives them a clue as to how the rest of the growing season will unfold. The erratic rainfall can cause misinformation and mislead farmers to make wrong decisions, given that the dry season is already gradually prolonged. Some signs such are mere smells (51.4%) that Indigenous communities rely on to predict whether it is going to rain or not at a particular time are still en vogue.

Some people are gifted to predict the onset of first rains through weather smells, especially in the mornings of February, March and April. The sounds of some insects and birds are common indigenous weather forecasting tools in many communities of the Bui Plateau (73.7%). One such bird is the *Senegalese Cowcow*, which sings in the morning or any time of the day to announce rains in about the next 10 to 60 minutes. Also, the prattling of the *Cameroon Mountain Francolin* indicates good weather. Insects like crickets cackling at night is an indicator that there will be no rain. Another visible indicator of cessation of the wet season is swarms of dragonflies that fly eastwards from October to November. In the absence of conventional weather forecasting, farmers in the Bui Plateau also read weather signs through the behaviour of some plants (*Scadaxus multiflorous*) (49.6%), (Figure 3), which blossoms only once a year in late February to early March. This plant has been used for generations in reading the onset of the first rains.

Figure 3: *Scadoxus multiflorous* blooming in late February to early March.

Once it blooms, the wet season will begin in about three to four weeks. Some farmers in Shisong affirmed that reading weather signs through the behaviour of plants and animals was handed to them by their great-grandfathers. IK handed by forefathers from whom they acquired farming experience has had long-standing and proven experience of weather forecasts from which they have profited. From such practices, farmers foresee rainfall patterns during the growing season. During the dry season, indigenous farmers also study the red-yellowish atmospheric aerosol loading to make decisions about their farming activities (Figure 4).

Figure 4: Atmospheric aerosol colouration as an indicator of the severity of the dry season.

Aerosol colouring of the atmosphere occurs from December till the start of the rainy season. This colouring indicates the appropriate time for farmers to start raising *'ankara'* on farms. Raising *ankara* is through the burying of maize stalks before burning. *Ankara* is also practised in newly opened fields. Bush burning for agricultural activities, pasture regeneration and dry season dust storms are the main sources of local aerosol loading into the atmosphere in the Bamenda Highlands of Cameroon during the dry season. From February, rain clouds (*cumulo-nimbus*) start building. Through the gathering of clouds (95.5%) such as a small *alto-cumulus* and *strato-cumulus* (Figure 5), community elders, weather seers and people with experience in reading weather signs can predict the exact date that the wet season begins.

Figure 5: Rain clouds in late February indicating the onset of rains

Other indicators of Indigenous weather forecasting include star constellation (60%), extreme temperatures (55.9%) and sequence of yearly weather events to determine what the climate would be in a farming season (42.9%).

Local weather knowledge in agrarian practices

A local farmer's ability to make informed decisions is largely governed by personal experiences acquired over the years. In the absence of credible scientific weather information systems to farmers, they must resort to what is at their disposal. Even when scientific weather systems are broadcast on the media, they appear hard to understand by rural farmers because of low levels of formal education (Table 3).

Variables	Yes		No		Undecided	
	F	%	F	%	F	%
Both local & scientific knowledge in weather forecasting are produced through observation	486	81.4	55	9.2	56	9.4
Formal education or training is not needed to acquire skills in Indigenous weather forecasting	418	70	59	10	120	20.1
Local knowledge is simple to understand	433	72.5	106	17.8	58	9.7
Local knowledge of weather prediction does not require the use of sophisticated tools	450	75	80	13	67	11.2
Local weather predictions are more accurate for farming decision-making	372	62	163	27	62	10.4
Local weather reading entails great spirituality	313	52	208	35	76	12.7
Scientific knowledge in weather follows procedures; local knowledge is unregulated & haphazard	439	74	88	15	70	11.7
Scientific weather forecasting and local predictions are mutually exclusive	346	58	174	29	77	12.9
Scientific weather forecasting should only supplement Indigenous approaches	318	53	160	27	119	19.9
Scientific weather forecasts are faulty	338	56.6	142	23.8	117	19.6
Traditional knowledge of weather prediction requires no financial investments	391	65	104	17	102	17.1

Table 3: Farmers' perception of the nature of local and scientific weather knowledge.

Weather forecasts broadcast by local media such as Cameroon Radio Television (CRTV), Spectrum Television (STV) and Equinox TV are often not understood by rural farmers. Local weather knowledge is simpler to understand than conventional scientific knowledge. Both local and scientific knowledge in weather forecasting over the years is produced through observation, experimentation and validation. Scientific knowledge in weather reading follows certain procedures in its production process, but technology local knowledge is unregulated and haphazard or unorganised by oral tradition.

Changing Environmental Conditions in the Bui Plateau

The impact of anthropogenic activity on the Bui Plateau has been able to evolve and develop social structures, subject not only to great forces of nature and occasional perturbations of the delicate steady state of nature but also exposed livelihood and life support systems like ecosystem services to irreversible damages. In the 1970s, the agrarian system was characterised by flat ridging, high coffee prices, and massive deforestation to establish new farmlands and plant eucalyptus (Table 4).

Period	Activities	Weather traits	Changes
1970s	Flat ridging, massive deforestation, high coffee prices, planting of eucalyptus	Regular onset of first rains in mid-March	Abundant water resources; unperceived changes
1980s	The decline in coffee prices, massive deforestation, the emergence of eucalyptus plantations, and massive elimination of coffee farms in the mid-1980s due to the slump of prices at the world market	Regular onset of first rains in mid-March, severe droughts	Abundant water resources; moderate changes
1990s	The advent of the application of chemical fertilizers in the early 1990s	Irregular onset of first rains, high frequency of extreme weather events	Drop in stream volumes; moderate vulnerability
2000s	Application of chemical fertilizers to boost crop production, emergence of cropper-herder conflicts	The irregular onset of early rains, frequency of extreme weather events (floods & droughts), increasing temperatures	Mounting water scarcity; high vulnerability
2010s	Spray weeding, fast-maturing crops, intense application of chemical fertilizers, caterpillar invasions during early growing season	Uncertain weather patterns, irregular rainfall, swelling temperatures	Emerging water insecurity; severe vulnerability
Since 2020	More seasonal crops *(Solanum potato)*	Irregular rainfall, plunging temperatures	Water & food insecurity; severe vulnerability

Table 4: Farmers' perception of agrarian evolution on the Bui Plateau.

There was the regular onset of the wet season in mid-March. Water resources were abundant. There were hardly noticeable environmental changes. With the drop in coffee prices in the mid-1980s, large-scale deforestation of natural forests and the emergence of large-scale eucalyptus plantations. With the fall in coffee prices, farmers eliminated their coffee farms and transformed them into eucalyptus plantations and farmlands in the mid-1980s. Rainfall was regular with the onset first rains in mid-March. The drought of 1983-84 caused agitation in farming communities. With these, there were no major changes in water resources.

The drought of the early and mid-1980s caused minor environmental changes like a drop in crop production. From the 1990s, there was already a remarkable drop in food production, which initiated the advent of chemical fertilizer application. The onset of the first rains became irregular and extreme weather events like dry spells, stormy weather and floods increased. In July 1998, hail stones destroyed crops all over Bui. Water levels dropped remarkably in local streams. The inhabitants could already perceive that their livelihoods were vulnerable to changing environmental conditions. Civil society organizations introduced eucalyptus replacement to save watersheds. From the 2000s, reasonable food crop production for maize could only be boosted by the application of chemical fertilizers. Temperatures plunged and the onset of the first rains became very irregular. Mounting water scarcity became a daily reality, leading to the emergence of water scarcity problems. The onset of the Anglophone crisis in 2016 has aggravated the climate crisis as some communities are on the verge of food and water insecurity.

Discussion

Indigenous and local practices (ILP) are an outcome of the application of context, culture and location-specific knowledge to solve problems [1]. The close relationship of indigenous peoples with their environment makes them sensitive to the effects of *'global warming'*. Indigenous people tend to live in places that are worst hit by the impacts of environmental change and their poverty exacerbates vulnerability [21]. Local people make agrarian decisions based on perceptions of their environment through the behaviour of some plants, and animals, reading signs of the atmosphere and many other Indigenous environmental practices. In the Bui Plateau of the Bamenda Highlands of Cameroon, dark clouds, according to indigenes signify approaching heavy rain [6]. *Ethno-meteorology* is a mystery and only some members of the community are gifted in reading and interpreting cloud patterns [22]. Some of the predictions of *'cloud watchers'* often miss out and can be very misleading because of changing climatic and environmental conditions.

Indigenous weather prediction does not require classy tools. Formal education or training is not needed to acquire skills in local weather forecasting [6]. Exercising local knowledge in weather prediction requires no financial investments. Despite gaping differences, scientific weather forecasting and local predictions are mutually exclusive. Local approaches to weather predictions are often accurate and as such are the best for making the right decisions in farming activities. Whereas scientific weather forecasting is purely secular, local knowledge of weather reading entails a great measure of spirituality. Indigenous peoples are among the first to face the direct consequences of climate change, owing to their dependence on and direct relationship with environmental resources [23].

Limitations arise on how both indigenous and scientific knowledge systems are viewed, which can increase the perceived inferiority of traditional knowledge to modern scientific knowledge [24]. Traditional knowledge is viewed to be closed, parochial, unintellectual, primitive and emotional, part of a residual, traditional and backward way of life, while contemporary knowledge is open, systematic and objective, centred on rationality and intelligence and centred within the developed world [5]. Whenever the two branches of knowledge are operating within the same environment, contemporary knowledge tends to dominate local traditional knowledge [6,26]. Currently, it may be difficult to delineate what are local traditional farming methods per se because of current development interactions which may have caused much influence of the local farming practices with scientific practices [5]. This is because local small-scale farmers have contact with the scientific community (agricultural extension officers and NGOs) who may have influenced much of their knowledge system and practices, making it very difficult to disentangle the two farming practices due to their influences and similarities [27,28].

Both indigenous and scientific knowledge have their limitations in providing informed solutions to social environmental management practices [6]. Nevertheless, both modern and indigenous traditional knowledge systems should complement rather than compete by incorporating respective economic, social and political perspectives that are useful and beneficial to the management of natural resources for the survival of the community [29]. Knowledge should be at the centre of creating solutions for some environmental problems, for it has evolved from the local community as opposed to scientific knowledge [25].

Traditional environmental knowledge has the advantage of being directly linked to household daily activities [30]. It is concerned with the immediate necessities of people's daily livelihoods and can provide a short-term and immediate solution to a means of survival in the community, making it meaningful [31]. It may also be useful under transitory conditions, as opposed to contemporary science developed through research and principles for solving global problems without a local origin nor link to the social, cultural, political and physical environment of a specific local area and removed from the daily lives of the people [25]. Researchers acknowledge the dynamism of local knowledge in providing solutions and coping with new environmental and economic hardships in society [1,5], with a further acknowledgement that some local farmers have succeeded in their farming systems by combining local farming methods with scientific knowledge [32,33].

Conclusion

The dearth of meteorological data necessitates the use of indigenous perceptions. The sources of weather activities and local weather information, farmers'' knowledge of weather forecasting, farmers' perception about the nature of local and scientific weather knowledge, perception of climate variability, and perception of factors influencing indigenous environmental knowledge and practices. Key actions for integrating traditional and scientific climate change adaptation approaches in Cameroon could include demonstration projects in collaboration with rural and indigenous communities; action research on key concerns and issues; information and communication technologies to record, manage and transmit indigenous knowledge and know-how; training to build local capacities in relevant multimedia techniques and international workshops and seminars to promote reflection and dialogue. In responding and adapting to climate issues, there is a strong need to adopt integrated scientific, social science and traditional knowledge approaches. An integrated approach enables local communities to address current and projected climatic risks and to identify appropriate response solutions. Rather than using indigenous knowledge only, or discarding it completely, its incorporation into climate change policies can lead to the development of effective, cost-effective, and sustainable adaptation strategies. Indigenous knowledge provides suitable entry points for research and development on climate change adaptation practices.

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