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A REVIEW OF SUBSISTENCE FARMERS' INDIGENOUS KNOWLEDGE OF SEASONS AND ITS IMPORTANCE IN CLIMATE CHANGE ADAPTATION

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ABSTRACT
Farmers use indigenous knowledge of seasonal climate predictions to plan their agricultural calendars to ensure sustainable production of subsistence crops. The present study presents a review of the literature on climate change and its effects on subsistence production in Limpopo Province and South Africa. Research from Africa and other regions supports existing literature, offering essential insights into seasonal variations, their effects on rain-fed agricultural productivity, and the measures for adaptation and mitigation. The review details small-scale farmers' understanding of the four seasons (summer, winter, spring, and fall), including their corresponding months, distinctive features, and relevant agricultural practices. Plant phenology such as change in fruiting and brooding period signals seasonal variations. Integrating indigenous and modern knowledge systems into environmental policy processes can enhance decision-makers comprehension of the role indigenous knowledge plays in shaping perceptions, impacts, and adaptations related to climate change. This could be a crucial strategy for mitigating climate change susceptibility, strengthening the resilience of small-scale farmers, and augmenting their adaptive capability.

KEY WORDS
Climate change, indigenous knowledge, seasons, seasonal change, seasonal indicators, agricultural calendar.

Climate change and fluctuation adversely affect the rain-fed subsistence agriculture of small-scale farmers in rural communities. Research on climate change in the rural areas of Limpopo Province, South Africa (Kruger & Nxumalo, 2017; Ziervogel et al., 2014) demonstrates that climate change and variability negatively impact subsistence crop production. The research indicates that climate change and variability are accountable for seasonal alterations, adversely affecting the agricultural calendar and the quality of crop production.

Subsistence farmers depend on indigenous knowledge as the fundamental framework for interpreting meteorological forecasts and making decisions regarding their agricultural operations (Elia et al., 2014). The farmers extensively depend on indigenous knowledge for seasonal predictions, closely associated with climate change adaptation measures (Zvobgo et al., 2023). Apraku et al. (2021) concede that small-scale farmers can forecast rainfall and seasonal variations, and provide alerts for climate-related calamities, by utilising social, biophysical, and biological markers. The ability to predict rainfall and the commencement of the planting season predominantly exists among the elderly and a certain group referred to as rainmakers. Chaudhary et al. (2022) attest that indigenous practices associated with climate-resilient agriculture involve monitoring the flowering of coffee and the blooming of peach trees as indicators of the arrival of rainfall. The commencement of the rainy season aligns with the blossoming and emergence of new foliage in plants, signifying a heightened increase in atmospheric humidity (Apraku et al., 2021). Certain plants possess the innate ability to detect a reduction in water availability, signaling the conclusion of the rainy season; consequently, they may shed their leaves or fold them as a natural mechanism to conserve water and energy (Rankoana, 2016). These observations corroborate the perspective of Apraku et al. (2021) that farmers use their indigenous knowledge to forecast seasonal weather. This knowledge is essential for the design, development, and dissemination of forecasts for effective climate change adaptation. Chaudhary et al. (2022) agree that the behaviour of certain plant species is likely influenced by their pronounced preference for moisture or humidity.

Change in the summer temperature patterns resulted in a deficiency of historically prolonged rainfall and wet seasons, whereas winter has become warmer due to heightened precipitation (Mekonnen et al., 2021). These alterations in seasonal patterns are markedly evident; previously, where there was more rainfall and greater harvest yields, whereas currently, precipitation is erratic, and the crops often perish due to excessive heat resulting from inadequate rainfall. Seasonal variations significantly influence labour fluctuations and diminished yields in agricultural production systems (Apraku et al., 2021). Varah and Varah (2022) concede that the interconnection of meteorological conditions, agricultural practices, and socio-economic activity constitutes seasonal calendars. Comprehending the seasons motivates individuals to grow subsistence crops, considering soil fertility, texture, and crop diversity (Mugambiwa, 2018), thereby improving food crop output in reaction to climate change (Oladele & Amara, 2024).

This review examines subsistence farmers' understanding of seasonal changes and variations, their effects on subsistence crop production, and the adaptation strategies employed to maintain crop yields amidst these seasonal fluctuations in Limpopo Province, South Africa. The examination of literature regarding Bapedi ethnography provides subsistence farmers' understanding of seasonal patterns and their distinctive traits, whereas the literature on climate change offered insights into climate change and the importance of indigenous adaptation strategies for managing seasonal fluctuations to maintain rain-fed agricultural output. These observations are supported by national and international literature regarding seasonal knowledge and its changes, as well as the application of indigenous knowledge in climate change adaptation.

METHODS OF RESEARCH

The study adopted a systematic literature review methodology to describe subsistence farmers' knowledge of seasons, seasonal variations, and their effects on the agricultural calendar of subsistence crop farmers. The main themes that guided the literature search were subsistence food production, perspectives on climate change and its consequences, and developed options for mitigation and adaptation. This research utilised databases such as Semantic Scholar, Google Scholar, ResearchGate, Elsevier, Taylor & Francis, Sage, and Wiley online libraries as the main sources of information. Relevant literature sources were chosen and examined irrespective of their publication dates. This review presents the indigenous knowledge of seasonal patterns in both vernacular and English, knowledge of seasonal variation and change, as well as the effects of seasonal shifts on subsistence crop production.

RESULTS AND DISCUSSION

Table 1 below presents four main seasons, identifying characteristics and agricultural activities performed in the seasons.

Table 1 – Knowledge of the Seasons*

Seasons	Identifying characteristics	Agricultural activities
Marega (winter) March-July	Dry season. Trees shed leaves. Grass dries out	Harvesting, threshing and storage of seeds
Seruthwane (Spring) August-September	First rain expected Flowering of plants	Preparation of the fields and gardens Seed preparation
Selemo (summer) October-January	Hot weather and high humidity. Rainy season	Ploughing of fields and gardens
Lehlabula (autumn) February-March	Persistent rain to sustain the crops	Harvesting and consumption of crops

**Adapted from Mönnig (1964) and Van der Walt and Fitchett (2020).*

Four distinct seasons are identified. The seasons delineated in the Bapedi ethnography are annual intervals characterised by distinct climatic conditions. Each possesses its own light, temperature, and meteorological cycles that recur annually. The Bapedi predominantly allocate their time based on their traditional agricultural techniques, which are influenced by the seasons and associated farming activities. The primary distinguishing features are climatic, such as summer, autumn, winter, and spring (Mönnig, 1964). Van der Walt and Fitchett (2020) and Moonig (1964) concede that the statistical classification of seasons includes summer from October to March, autumn in April and May, winter in June, and spring in September.

Phenomena such as foliar abscission, desiccation of grasses, floral emergence, precipitation, and sustained rainfall serve as primary indications of seasonal transitions, delineating the commencement and conclusion of seasons. The flowers and leaf emergence of the *Senegali* species indicate the onset of summer. Ziervogel and Opere (2021) concur that subsistence farmers in South Africa's rural communities use many local weather indicators, including flora, fauna, insects, celestial bodies, and wind patterns, to forecast seasonal climate conditions.

Local farmers employ this form of indigenous knowledge to forecast the commencement and conclusion of planting seasons. The review findings indicate that farmers extensively use plants for seasonal forecasting. For example, before the onset of rain, tree species generate leaves and blossoms, which farmers use as markers for predicting the forthcoming rainy season (Mönnig, 1964). Farmers use the appearance of new tree leaves, blossoms, and fruits to forecast the arrival of rain. As rainfall approaches, trees generate foliage and blossoms, prompting farmers to utilise these local signs to ready themselves for the forthcoming agricultural season. Mafongoya and Ajayi (2017) indicate that numerous trees blossom and bear fruit at the onset of the season, which signifies a promising rainy season. Ubisi et al. (2017) concede that large-scale farmers also rely and use these seasonal indicators to inform decisions on planting schedules and crop variety selection.

Research undertaken by Ziervogel et al. (2014), Ncube and Lagardien (2015), Jiri et al. (2016) indicates that the emergence of plant buds and follicles signifies the commencement of summer and the wet season, allowing farmers to ready their fields for cultivation. Most subsistence farmers utilise indigenous climatic indicators for seasonal forecasting and to organise their agricultural practices (Ubisi et al., 2017). Ncube and Lagardien (2015) observed that farmers rely exclusively on indigenous knowledge as their adaptation strategy, use it to forecast harvesting and planting seasons by examining climate indicators. Elia et al. (2014) assert that rural agricultural communities in Tanzania depend on traditional knowledge for seasonal forecasting. These observations support Nyong et al. (2007) findings that rural people rely on indigenous knowledge for local decision-making, particularly in weather forecasting and predicting the forthcoming agricultural season.

Numerous international researches validate the conclusions of the indigenous understanding of seasonal changes among small-scale farmers in Limpopo Province, South Africa. For instance, Mafongoya and Ajayi (2017) indicate that seasonal knowledge varies across individuals based on their methods of using the natural environment and resources for sustenance. Ndlovu et al. (2023) acknowledge that farmers prefer indigenous forecasts to scientific ones, prioritising their accumulated experiences. The farmers depend on historical trends, meteorological observations, and indicators to develop anticipations regarding the weather (Kolawole et al., 2014). The farmers' comprehension of the seasons underscores a significant practical focus on planning and exhibits dynamism, facilitating the incorporation of novel features (Ndlovu et al., 2023). Some aspects of the natural environment, such as plant phenology and the appearance and movement of the fauna, determine the onset and quality of the seasons. For example, studies done in southern Africa highlight that if certain trees bear fruit at certain periods, then this indicates either a good or poor rainfall season (Jiri et al., 2016). Early fruiting in November to early December indicates low rainfall, late fruiting in February to March indicates a good season, and no fruit at all indicates a serious drought (Shoko & Shoko, 2013). The disappearance and delayed fruiting of trees and the profuse fruiting of certain trees, including the delayed regrowth of grasses from August to October, have for a long time indicated droughts to come (Mapfumo et al., 2015). Additionally, the sounds from certain insects that emerge from overwintering/hibernation (Mapfumo et al., 2015) tend to signal the start of a season and planning by farmers (Jiri et al., 2016).

Table 2 – Knowledge of the Seasonal Change/Variation*

Seasons	Seasonal Variations Adapted to	Impacts on Agricultural Production
Marega (winter)	Mild to warm with precipitation.	Damage of crops leading to poor production
Seruthwane (Spring)	Little and delayed first rain. Flowering of plants delayed with poor quality flowers and foliage.	Delayed planting
Selemo (summer)	Delayed and unpredictable rainfall onset. Low and Infrequent drought and period floods. Dry spells.	Delayed agricultural activities (planting). Shortened growing season. Poor crop production
Lehlabula (autumn)	Little rain to sustain the crops. Poor crop production.	Little rain to sustain the crops. Poor crop production.

**Adapted from Mönnig (1964).*

Literature on Limpopo climate change and variability indicates that rainfall is sporadic, unexpected, poorly distributed, of low intensity, and ephemeral (Kruger & Nxumalo, 2017). Ambiguities at the onset of the wet season led farmers to overlook ploughing and planting schedules. Altered seasonal patterns interfere with farmers' traditional planting schedules, resulting in a modification of planting dates (Van der Walt & Fitchett, 2020). Disruptions to the agricultural calendar led to diminished crop yields, causing food shortages due to postponed or absent cultivation (Tshiala & Olwoch, 2010). Farmers define drought as the lack of precipitation throughout the primary rainy season (Rankoana, 2016). The delayed onset of the rainy season, inadequate rainfall distribution, cold, and flooding have adversely affected cattle and agriculture in semi-arid areas (Kruger & Nxumalo, 2017). In South Africa, numerous rural communities continue to rely on rain-fed agriculture, with subsistence crop farming as the primary livelihood activity (Ziervogel et al., 2014; Ubisi et al. (2017). Traditional agricultural practices such as intercropping have historically ensured food security; however, contemporary trends indicate diminished output attributed to delayed and erratic rainfall resulting from seasonal fluctuations (Kruger & Nxumalo, 2017). Rankoana (2016) asserts that climate variabilities, including the postponed onset of the rainy season, mid-season droughts, heat waves, and frost-induced droughts, have significantly affected subsistence crop production techniques.

Coetzee et al. (2016b) support that rainfall regimes are erratic, unevenly distributed, and in short supply, leading to crop failure and increasing vulnerabilities to food insecurity in Southern Africa. As a result, sub-Saharan Africa and Southern Africa, in particular, are witnessing increasing vulnerability to poverty, protracted food insecurity, and environmental degradation (Ndlovu et al., 2020). Van der Walt and Fitchett (2020) observe that the current seasonal variations adversely affect economic and agricultural practices, influenced by the length and timing of the growing seasons, the timing of sowing and harvest, and the need for irrigation and fertilization. The shifting rainy season results in uncertainty and confusion as to when and what to plant (Radeny et al., 2019). Observations of delayed rains in Limpopo Province, which started around January instead of October in the previous year and ended around March instead of April in rural Zimbabwe, support the knowledge of shifting seasons (Ndlovu et al., 2020). The shifting rainy season (from around January to May, as opposed to the known season from October to April) complicated the cropping calendars and compromised the farming season plans for both cropping and livestock breeding. This represents a significant departure from the previous season, when November was traditionally a wet and cropping month, marked by abundant rainfall. Sherpa (2023) affirms that seasons have become unpredictable, winters are getting colder, and glaciers are melting due to increasing temperatures. Moreover, due to untimely seasons, there has been inconsistent planting, which could adversely affect crop yield. Seasonal uncertainties caused by climate change could be primarily responsible for the respondents perceiving it to be relatively less effective than other practices. Sherpa (2023) notes that changes in seasonality pose a significant threat to their lives and livelihood. Fluctuation in seasonal timing and erratic rainfall patterns hindered optimal moisture conditions for the soils, which could have led to a low evaluation of its reliance and effectiveness. The untimely season might have made them unable to perform this activity at the appropriate time. Radeny et al. (2019) observe that farmers typically rely on indigenous knowledge for seasonal weather forecasts, using locally observed indicators and experiences to evaluate, predict, and comprehend local weather conditions and climate. Many African cultures and communities have built and established this type of weather forecasting through years of observation (Ziervogel & Opere, 2010), using various indicators to predict future weather conditions.

The review findings indicate that indigenous knowledge is key to weather forecasts and agricultural decisions concerning crop planting. The seasonal defining criteria outlined in Table 1 inform the commencement of agricultural activity. The farmers employ various adaptation strategies to address climate change and variability including the cultivation of drought-resistant crops, transitioning from long-season to short-season crops, and modifying their planting schedules. The farmers note certain traits during the beginning of the season, especially *Selemo*, throughout the rainy season, and at the commencement of ploughing. This knowledge is informed by a cosmology that illustrates a profound connection between the seasons and agricultural practices. Moonig (1964) asserts that this knowledge, together with an appreciation of biodiversity, has significantly influenced the development of subsistence farming systems. The natural environment largely informs all farming practices. For instance, the farmers meticulously monitor the emergence of specific insects or the development of plant species as indicators for the commencement of seasonal agricultural activities (Rankoana, 2016; 2022).

Small-scale farmers use their understanding of the seasons, in conjunction with observed alterations and fluctuations, to strategise their agricultural endeavors. Indigenous knowledge of seasonal weather predictions informs the decisions and activities taken to mitigate climate risk (Kruger & Nxumalo, 2017). The principal mitigation activity generally involves deferring planting season activities due to the noted inadequacy of rainfall throughout the summer, regarded as the rainy season. Jiri et al. (2016) concede that farmers remove fields and gardens while awaiting the initial adequate rainfall to facilitate planting. Anticipating adequate rainfall, which facilitates planting, allows farmers to determine the appropriate crops to cultivate in reaction to postponements in rain commencement. A transition from extended planting periods to short-season crops to adapt to variable climatic conditions. The farmers generally opt for early-maturing crop seeds for sowing when rain delays persist from late October to mid-November. Conversely, Mogomotsi et al. (2020) found that some farmers have concentrated on planning according to the agricultural calendar year, selecting crop types and varieties, managing crop areas, and implementing operational and management strategies, including irrigation scheduling, weeding, and fertilizer application.

The measures are domestic decisions aimed at mitigating the risk of suboptimal crop yields. However, the agricultural calendar adapts to seasonal fluctuations as farmers align their activities with the prevailing seasons (Ziervogel et al. 2014; Ncube and Lagardien 2015; Jiri et al. 2016).

Subsistence farmers previously sowed maize in September; however, due to climate change, they have altered the planting time to early November. Mugambiwa's (2018) research corroborates these results, demonstrating that climate unpredictability in Southern Africa has resulted in uncertainty and alterations to the planting schedule. On another note, the farmers previously sowed maize in September; but, due to climate change, they have altered the planting time to early November (Rankoana, 2016). The fifth assessment report (AR5) of the Intergovernmental Panel on Climate Change (Petzold et al., 2020) emphasises the significance of indigenous knowledge in climate change adaptation. The indigenous understanding of seasonal variations and their effects on agricultural practices is crucial for climate change adaptation, given the significant adverse impacts of climate fluctuations on subsistence output.

Tanyanyiwa (2018) corroborates the review findings, emphasising the significance of smallholder farmers' indigenous knowledge in weather and climate forecasting for improving their comprehension of forthcoming weather patterns and seasonal changes. Filho et al. (2023) add that smallholder farmers in Sub-Saharan Africa, when adjusting to climate impacts, depend on trusted information sources for climate decision-making, including the utilisation of indigenous knowledge for weather and climate forecasting (Mekonnen et al., 2021). Zvobgo et al. (2022) assert that farmers base numerous decisions on the forecast of the rainy season's commencement, rendering it the most crucial characteristic. The farmers use indigenous forecasts to inform context-specific climate decisions crucial for climate risk preparedness and resilience (Tanyanyiwa, 2018).

CONCLUSION

This research elucidates the role of indigenous knowledge about seasonal variations due to climate change, the impacts of these variations on agricultural production, and the adaptive measures employed to sustain subsistence crop production. The study highlights local communities' understanding of seasonal variations including delayed and unpredictable rainfall, reduced precipitation levels, irregular timing of rainfall onset and cessation, and an increased incidence of drought. These seasonal variations are signalled by plant phenology such as changes in the fruiting, and brooding period. Seasonal transitions disrupt the agricultural calendar, therefore impacting production. This assessment categorises seasonal differences as meteorological, segmenting the seasons into four approximately three-month periods, a system frequently used in temperate regions. The classification is additionally predicated on anticipated rainfall and its duration. However, the farmers use indigenous adaptation strategies such as a change of the planting calendar, to mitigate crop failure due to erratic rainfall associated with droughts and rainfall variability due to seasonal fluctuations. These adaptation practices could be integrated into climate change adaptation policies to develop bottom-up climate change response strategies.

REFERENCES

1. Apraku, A., Morton, J.F. & Gyampoh, B.A. (2021). Climate Change and Small-Scale Agriculture in Africa: Does Indigenous Knowledge Matter? Insights from Kenya and South Africa. Scientific African, 12, e00821.
2. Chaudhary, B. R., Erskine, W. & Acciaioli, G. (2022). Hybrid Knowledge and Climate-Resilient Agriculture Practices of the Tharu in the Western Tarai, Nepal. Frontiers in Political Science, 4, 969835. https://doi.org/10.3389/fpos.
3. Elia, E.F., Mutula, S. & Stilwell, C. (2014). Indigenous knowledge use in seasonal weather forecasting in Tanzania: the case of semi-arid central Tanzania, South Africa. Journal of Library and Information Sciences, 80 (1), 18–27.
4. Filho, W.L., Wolf, F., Totin, E., Zvobgo, L., Simpson, N.P. et al. (2023). Is Indigenous Knowledge Serving Climate Adaptation? Evidence from Various African Regions. Development Policy Review. Available at: https://doi.org/10.1111/dpr.12664.
5. Jiri, O., Mafongoya, P.L., Mubaya, C. & Mafongoya, O. (2016). Seasonal Climate Prediction and Adaptation Using Indigenous Knowledge Systems in Agriculture Systems in Southern Africa: A Review Journal of Agricultural Science, 8(5), 156-127. ttp://dx.doi.org/10.5539/jas.v8n5p156.
6. Kolawole, O.D., Wolski, P., Ngwenya, B. & Mmopelwa, G. (2014) Ethno-meteorology And Scientific Weather Forecasting: Small Farmers and Scientists' Perspectives on Climate Variability in the Okavango Delta, Botswana. Climate Risk Management, 4, 43–58. https://doi.org/10.1016/j.crm.2014.08.002.
7. Kruger, A.C. & Nxumalo, M. (2017). Surface Temperature Trends from Homogenized Time Series in South Africa: 1931–2015. International Journal of Climatology, 27(5), 1–52. https:// doi.org/10.1002/joc.4851.

8. Mekonnen, Z., Kidemu, M., Abebe, H., Semere, M., Gebreyesus, M. & Worku, A. et al. (2021). Traditional Knowledge and Institutions for Sustainable Climate Change Adaptation in Ethiopia. Current Research in Environmental Sustainability, 3, 100080. doi:https://doi.org/10.1016/j.crsust.2021.100080.
9. Mogomotsi, P.K., Sekelemani, A. & Mongoose, J.E.G. (2020). Climate Change Adaptation Strategies of Small-Scale Farmers in Ngamiland East, Botswana. Climatic Change, 159(3), 441–460, doi:10.1007/s10584-019-02645-w.
10. Mönnig, H.O. (1967), The Pedi, J.L. Van Schaik, Pretoria.
11. Mugambiwa, S.S. (2018). Adaptation Measures to Sustain Indigenous Practices and the Use of Indigenous Knowledge Systems to Adapt to Climate Change in Mutoko Rural District of Zimbabwe. Jàmbá: Journal of Disaster Risk Studies, 10(1), a388, doi: 10.4102/jamba.v10i1.388.
12. Ncube, B. & Lagardien, A. (2015). Insights into Indigenous Coping Strategies to Drought for Adaptation in Agriculture: A Karoo Scenario. Cape Peninsula University of Technology, Cape. https://www.wrc.org.za/wp-content/uploads/mdocs/2084-1-14.pdf.
13. Ndlovu, E., Prinsloo, B. & Le Roux, T. (2020). Impact of Climate Change and Variability on Traditional Farming Systems: Farmers' Perceptions from South-West, Semi-Arid Zimbabwe. Jàmbá: Journal of Disaster Risk Studies, 12(1), a742. https:// doi.org/10.4102/jamba. v12i1.742N.
14. Ndlovu, J., Ndlovu, M., Nyathi, D. (2023). The Role of Indigenous Climate Forecasting Systems in Building Farmers' Resilience in Nkayi District, Zimbabwe. In: Chatterjee, U., Shaw, R., Kumar, S., Raj, A.D., Das, S. (eds) Climate Crisis: Adaptive Approaches and Sustainability. Sustainable Development Goals Series. Springer, Cham. https://doi.org/10.1007/978-3-031-44397-8_1
15. Oladele, O.I. & Amara, A. (2024). Farmers' Use of Indigenous Knowledge on Climate Change Adaptation Across Farming Systems and Agroecological Zones of Sierra Leone. AlterNative, 1–11.
16. Nyong, A., Adesina, F. & Osman Elasha, B. (2007). The Value of Indigenous Knowledge in Climate Change Mitigation and Adaptation Strategies in the African Sahel. Mitigation, Adaptation Strategies and Global Change, 12, 787–797. https://doi.org/10.1007/s11027-007-9099-0.
17. Petzold, J., Andrews, N., Ford, J.D., Hedemann, C. & Postigo, J.C. (2020). Indigenous Knowledge on Climate Change Adaptation: A Global Evidence Map of Academic Literature. Environmental Research Letters. 15(11),113007. https://doi.org/10.1088/1748-9326/abb330.
18. Radeny, M., Desalegn, A., Mubiru, D., Kyazze, F., Mahoo, H., Recha, J., Kimeli, P. & Solomon, D. (2019). Indigenous Knowledge or Seasonal Weather and Climate Forecasting Across East Africa. Climatic Change, 156:509–526.
19. Rankoana, S.A. (2016). Perceptions of Climate Change and the Potential for Adaptation in a Rural Community in Limpopo Province, South Africa. Sustainability J., 8(8), 1-10.
20. Rankoana, S.A, (2022), Indigenous Knowledge and Innovative Practices to Cope with Impacts of Climate Change on Small-Scale Farming in Limpopo Province, South Africa. International Journal of Climate Change Strategies and Management, 2(2),1-10.
21. Sherpa, T.O. (2023). Indigenous People's Perception of Indigenous Agricultural Knowledge for Climate Change Adaptation in Khumbu, Nepal. Frontiers in Climate. 4,1067630. doi: 10.3389/fclim.2022.1067630.
22. Shoko, K., & Shoko, N. (2013). Indigenous Weather Forecasting Systems: A Case Study of the Abiotic Weather Forecasting Indicators for Wards 12 and 13 in Mberengwa District Zimbabwe. Asian Social Science, 9(5), 285-297. http://dx.doi.org/10.5539/ass.v9n5p285
23. Tanyanyiwa, V.I. (2018.) Weather Forecasting Using Local Traditional Knowledge in the Midst of Climate Change in Domboshawa, Zimbabwe, vol 2. Springer, Cham. In: Filho, W.L. et al. (eds.), Handbook of Climate Change Communication: Vol. 2, Climate Change Management, https://doi.org/10.1007/978-3-319-70066-3_1.

24. Tshiala, M.F. & Olwoch, J.M. (2010). Impact of Climate Variability on Tomato Production in Limpopo Province, South Africa. African Journal of Agricultural Research, 5(21), 2945–2951.
25. Ubisi, N.R., Mafongoya, P.L., Kolanisi, U. & Jiri, O. (2017). Smallholder Farmer's Perceived Effects of Climate Change on Crop Production and Household Livelihoods in Rural Limpopo Province, South Africa. Change and Adaptation in Socio-Ecological Systems, 3(1), 27–38. doi:10.1515/cass-2017-0003.
26. Van der Walt, A.J. & Fitchett, J.M. (2020). Statistical Classification of South African Seasonal Divisions on the Basis of Daily Temperature Data. South African Journal of Science,116(9/10), Art. #7614. https://doi.org/10.17159/ sajs.2020/7614
27. Varah, F. & Varah, S.K. (2022). Indigenous Knowledge and Seasonal Change: Insights from the Tangkhul Naga in Northeast India. GeoJournal, 87, 5149–5163. https://doi.org/10.1007/s10708-021-10559-3.
28. Ziervogel, Gina, Mark New, Emma Archer van Garderen, Guy Midgley, Anna Taylor, Ralph Hamann, Sabine Stuart-Hill, Jonny Myers, and Michele Warburton. 2014. "Climate Change Impacts and Adaptation in South Africa." Wiley Interdisciplinary Reviews: Climate Change. 5 (5): 605–620. doi:10.1002/wcc.295.
29. Zvobgo, L., Johnston, P., Olagbegi, O.M., Simpson, M.P. & Trisos, C.H. (2022). Vulnerability of Smallholder Farmers to Climate Variability in Chiredzi, Zimbabwe. Climate Risk Management, Pre-print.
30. Zvobgo, L., Johnston, P., Olagbegi, O.M., Simpson, M.P. & Trisos C.H. (2023). Role of Indigenous and Local Knowledge in Seasonal Forecasts and Climate Adaptation: A Case Study of Smallholder Farmers in Chiredzi, Zimbabwe. Environmental Science and Policy, 145, 13–28.