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Evolution of Agricultural Extension in Zimbabwe: Emerging Technologies, Training Needs and Future Possibilities

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ABSTRACT

Skills development needs of smallholder farmers have often been overlooked during the delivery of agricultural information due to a lack of curriculum reform and gaps between agricultural extension officers' (AEOs) training and farmers' changing needs. Recent evidence suggests that the greatest need for agricultural extension services is for new farmers and emerging agricultural technologies compared to well-established farmers and farming methods. On the contrary, lack of adequate extension skills has impeded the implementation

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and success of climate- and nutrient-smart agricultural technologies such as conservation agriculture and integrated soil fertility management in rainfed cropping systems. Here, we review the history of agricultural extension in Zimbabwe and the impacts of colonial heritage and restructuring on extension. We also present findings from recent research on AEO training and gaps in the curriculum. This research indicated that a gap in skills exists due to insufficient AEOs' training in essential areas such as farm management, market access, emerging technologies (for example, mobile phones) and supporting the changing needs of farmers. We demonstrate an urgent need for agricultural extension systems in Zimbabwe to explore new models in the field that equip AEOs with adequate training and skills which meet the needs of new farmers and emerging agricultural technologies.

Keywords: Conservation Agriculture, E-Extension, Integrated Soil Fertility Management, New Farmers, Smallholder Farmers, Skills Gap

1. INTRODUCTION

1.1. Agriculture in Zimbabwe

Agriculture is the backbone of the Zimbabwean economy (FAO, 2003; FAO, 2023), with a Gross Domestic Product (GDP) contribution of 10%. About 60-70% of the population in Zimbabwe draws livelihoods (employment and income) from agriculture (FAO, 2003; World Bank, 2019). This is a proportion equivalent to the rural population in the country (World Bank, 2018). The GDP contribution from agriculture has declined by 50% between 2000 and 2021 (World Bank and the Government of Zimbabwe, 2019) (Figure 1). This is due to reduced productivity emanating from several factors, including land degradation (Nezomba et al., 2015a), rainfall variability and climate change (Government of Zimbabwe and Ministry of Agriculture, 1995), low nutrient input supply (Mapfumo et al., 2015), lack of labour due to youth migration, and functioning markets (FAO, 2023). Following land reforms, changes in agrarian structures have also reduced agricultural productivity (Kasiyano, 2018).

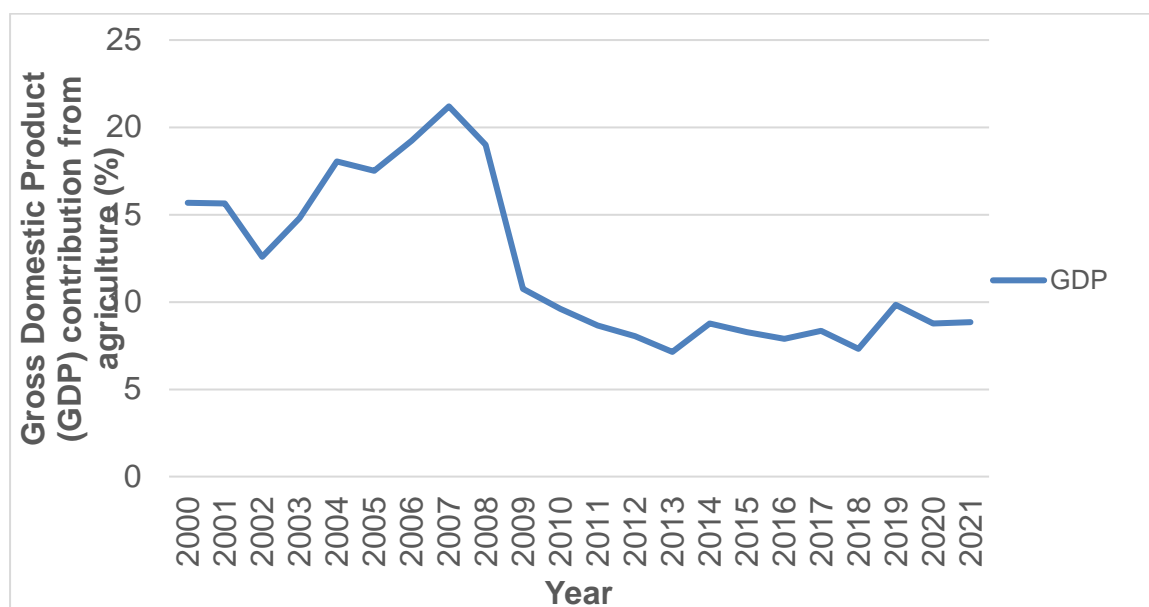


FIGURE 1: Chart Showing Agriculture GDP Trends Between 2000 and 2021 in Zimbabwe (Source: The Global Economy, 2024)

Zimbabwe is divided into five agroecological regions (FAO, 2006). These regions, also referred to as natural regions (NRs) are based on rainfall regime, soil quality, and vegetation, among other factors (Vincent, Thomas and Staples, 1961; Zimfact, 2020). Natural Region 1 has the best quality of land resources, but it declines towards NR5 (Moyo, 1991). Natural region 1 receives >1000 mm annum⁻¹ rainfall and NR5 receives <450 mm annum⁻¹ (Vincent, Thomas & Staples, 1961; Moyo, 1991). Climate changes resulted in the re-classification of Natural Regions (Figure 2) by the Zimbabwe National Geospatial and Space Agency (ZINGSA), Meteorological Services Department and Agricultural Extension Services (The Herald, 2021). This reclassification has seen most NR III, IV and V expand at the expense of NR1, IIa and IIb, with NR V sub-divided into Va and Vb (Banya, 2020).

Despite the sector's decline in its contribution to the country's GDP, the Government of Zimbabwe (GoZ) continues to intensify efforts towards increasing agricultural productivity (World Bank and the Government of Zimbabwe, 2019) through the employment of different programmes and frameworks (FAO, 2016). Agricultural farming in Zimbabwe comprises four major farming sectors, namely 1) Large scale commercial farms, 2) Small scale commercial farms, 3) Old and new resettlement schemes, and 4) Communal farms (ZNSA, 2019), with the population in communal farms making up to about 51% of Zimbabwe's population. Communal

farms occupy 42% of the total land area (ZNSA, 2019). Agriculture in this sector is primarily rain-fed, with the rainy season starting from October to April. Peak rains are received from December to February (Mupangwa, Walker and Twomlow, 2011). Smallholder farmers contribute most of the staple maize (*Zea mays* L.) and traditional cereal grains (finger millet-*Eleusine coracana*, pearl millet-*Pennisetum glaucum*, sorghum-*Sorghum bicolor*) supply in the country in addition to production of groundnuts (*Arachis hypogaea*), soya beans (*Glycine max*), common beans (*Phaseolus vulgaris*), vegetables, meat, milk and fuelwood (FAO, 2003).

Land use efficiency and productivity in smallholder farming systems could be increased using sustainable agricultural practices (e.g. conservation agriculture and integrated soil fertility management-ISFM), improved farmers' access to information, inputs and markets, and access to financing, infrastructure, training, and research and extension services (FAO, 1999; Gwandu et al., 2014; FAO, 2023). Farmer access to information is integral towards increasing productivity in these systems. The ratio of extension to farmer was reported to be 1:200 in commercial farms (Rukuni et al., 2006), with a larger ratio of 1:650 currently reported in smallholder cropping systems (The Sunday Mail, 2023). This paper combines reviewed literature on agriculture extension and the smallholder farming sector in Zimbabwe and structured questionnaires to explore gaps between agricultural extension, the needs of farmers and emerging climate- and nutrient-smart agricultural technologies across key stakeholders. The study aimed to recommend new modes of agricultural extension which could potentially strengthen and boost productivity and economic growth in this sector.

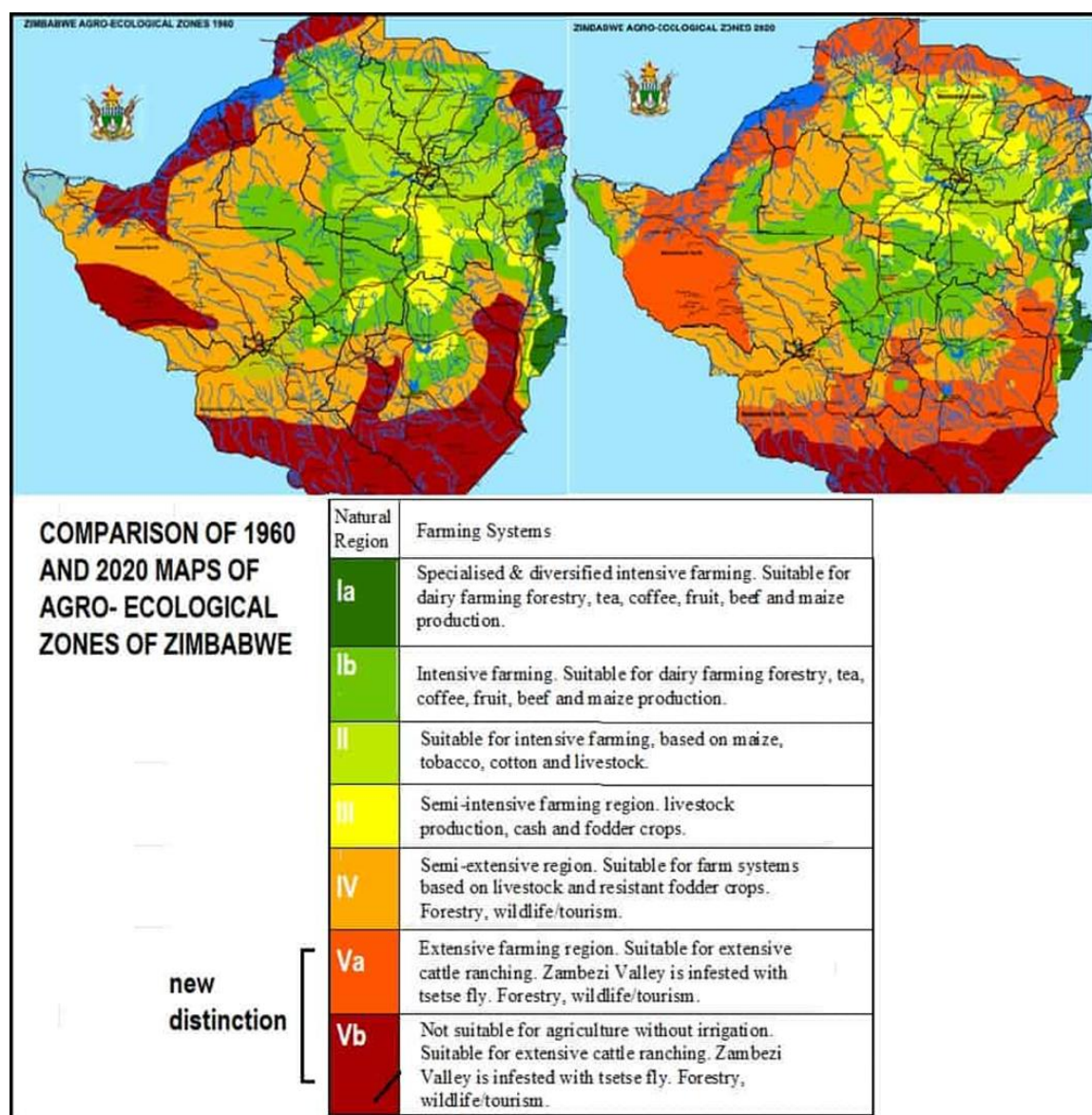


FIGURE 2: Map of Zimbabwe’s Agro-Ecological Regions in 1960 (left) and 2020 (right).
 (Source: Whole Earth Education, 2020)

1.2. History of Agricultural Extension in Zimbabwe: Colonial and Post-Independence Impacts

Agricultural extension has been defined from a technology transfer (UNDP, 1991), knowledge transfer (Bolding et al., 2003) and mode of agricultural extension transfer perspective (Bradfield, 1966; Kelsey & Hearne, 1963) where an out-of-school education process is employed for adults to learn by doing. Despite its numerous definitions (Zvavanyange, 2014), agricultural extension mainly involves movement, extrapolation, or flow of knowledge, information, technology, and services from a particular source to a receiver or client.

Agricultural extension in Zimbabwe was introduced by Alvord E.D. in 1927 (Hanyani-Mlambo, 2002; Zvavanyange, 2014). It started with nine agricultural demonstration workers who were employed to champion the management of land and livestock (Figure 3). The Master Farmer Training (MFT) program was then formed in 1935 to offer agricultural courses to farmers (Zvavanyange, 2014; Ngwenya et al., 2022). Several institutions were set up in Zimbabwe to train nationals as agricultural demonstrators who later joined the Department of Native Affairs (Zvavanyange, 2014). The Department of Conservation and Extension (CONEX) was formed in 1948 to offer extension support, mainly on soil conservation and master farmer training to commercial farmers (Maravanyika, 2013). It was approximately 20 years till a similar department was set up to offer technical and extension support to smallholder farmers. In 1969, the Department of Native Agriculture (DEVAG) was formed to support smallholder farmers with prescriptive extension approaches (i.e. cattle dipping) and master farmer training (Gadzirayi et al., 2008). Post-independence, the two departments amalgamated in 1981 to form the Department of Agricultural Technical and Extension Services (AGRITEX), which adopted the Master Farmer Training program. AGRITEX incurred challenges in its early years, which included the loss of experienced staff between 1981 and 1985 (Hanyani-Mlambo, 2002) and saw the department establishing and finding itself for most of the first 20 years (1980-2000) (Hanyani-Mlambo, 2002). In the 1990s, plural agricultural extension models were introduced with the entry of many developmental NGOs in the smallholder (rural) sector. In 2000, the Government of Zimbabwe undertook the Fast Track Land Reform Program (FTLRP), which aimed to redress land imbalances and empower native farmers (Zvavanyange, 2014). The program ushered in new categories of farmers (A1 and A2) as Large-Scale commercial farms were subdivided. This increased pressure on AGRITEX as the clientele “smallholder” farmers expanded, yet resources dwindled.

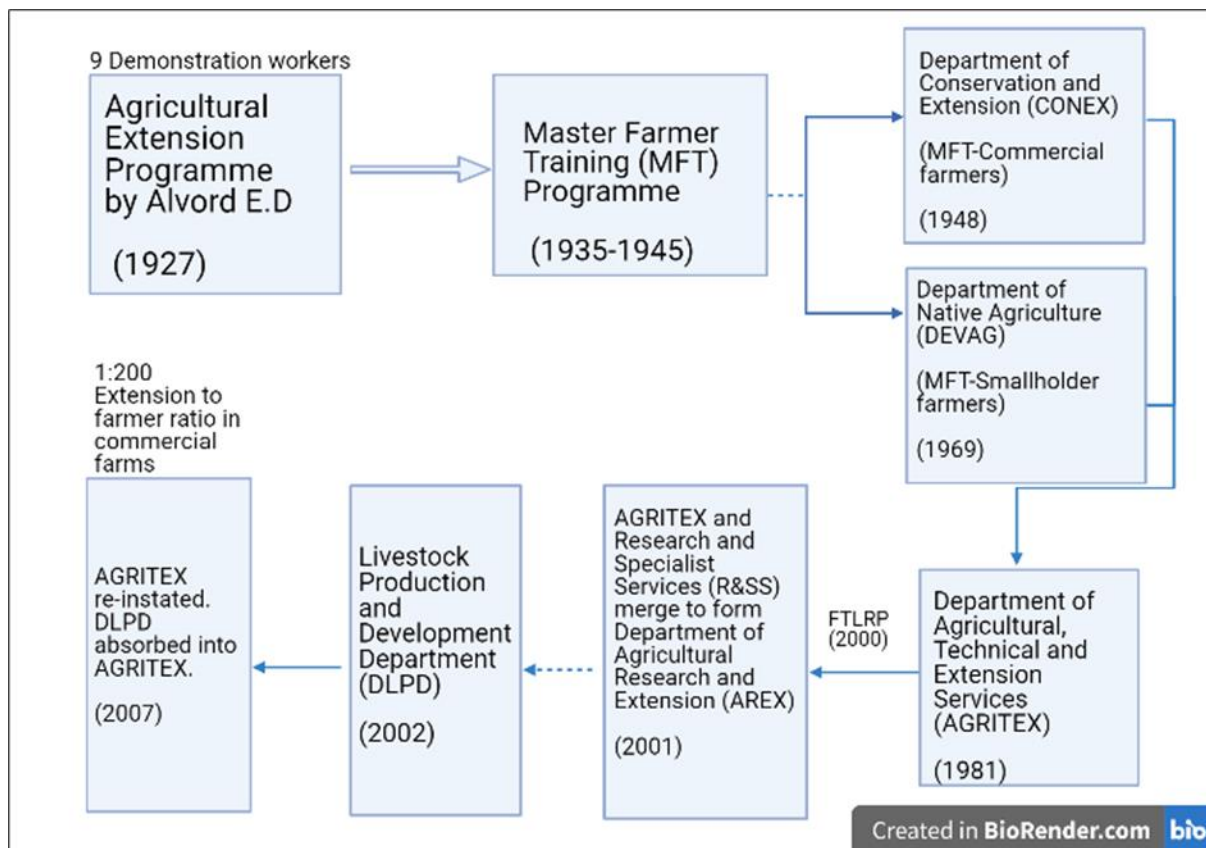


FIGURE 3: The History of Agricultural Extension in Zimbabwe. FTLRP refers to the Fast Track Land Reform Program. The Dotted Line Denotes Split/Division Within the Respective Department. (Sources: Zvavanyange, 2014; Hanyani-Mlambo, 2002; Gadzirayi et al., 2008; Maravanyika, 2013).

The Fast Track Land Reform Program became unpopular with the large-scale commercial farming community and saw a general decline in agricultural productivity, among other challenges, erasing hope for the newly resettled farmers. As agricultural productivity declined, the economic crisis in Zimbabwe started to deepen, as shown earlier by a decline in the country’s GDP (Figure 1). A year later, AGRITEX and the Department of Research and Specialist Services (DR & SS) merged to form the Department of Agricultural Research and Extension (AREX, Figure 3). In 2002, a new Department of Livestock Production and Development (DLPD) was formed to champion livestock extension and support (Zvavanyange, 2014). At the same time, many new extension actors moved in to fill the vacuum created by the immobilisation of AGRITEX due to limited resources. There was an increase in contract farming by smallholder tobacco (*Nicotiana tabacum*) farmers and the establishment of sugar cane (*Saccharum officinarum*) out grower schemes following the land reform program.

In 2007, AGRITEX was re-instated from AREX and absorbed by the Department of Livestock Production and Development (Figure 3). These structural changes within AGRITEX resulted in the loss of institutional memory and technical expertise essential in dealing with farmers, especially large-scale commercial farmers (Hanyani-Mlambo, 2002). Recruitment of new staff with limited technical expertise and practical knowledge of dealing with farmers and merging of two departments dealing with farmers from different socio-economic backgrounds resulted in AGRITEX experimenting and establishing itself as a service for all farmers, especially smallholder farmers, for a long time (Hanyani-Mlambo, 2002). Within the same year, there was massive support for the adoption of conservation agriculture (CA) targeted at smallholder farmers, largely funded by the Food and Agriculture Organization (FAO) and implemented by many Non-Governmental Organisations (NGOs). International Agricultural Research Centres such as the International Maize and Wheat Improvement Centre (CIMMYT) and the International Centre for Tropical Agriculture (CIAT) provided backstopping of conservation agriculture. On-farm research and demonstration trials were used to introduce and promote conservation agriculture to farmers with inputs (i.e. seed and fertiliser) provided to farmers on condition that conservation agriculture was adopted on their plots.

1.3. Emerging Climate and Nutrient Smart Technologies, and New Farmers: A Case Study on Conservation Agriculture and Integrated Soil Fertility Management

Conservation agriculture (CA) is a sustainable intensive farming practice promoted under three principles: minimum soil disturbance, crop residue retention, and crop rotations (FAO, 2011; Vanlauwe et al., 2014). Conservation agriculture was first introduced in North-east Zimbabwe in the late eighties to early nineties in the Musana communal area by Brian Oldrieve under the Contill Project led by the Institute of Agricultural Engineering (Marongwe et al., 2012). During this time, adopting on-farm and on-station activities promoted by Oldrieve was unsuccessful. Conservation agriculture was re-introduced in Zimbabwe in early 2000 to address the effects of increasing population growth and agriculture activities on land degradation, increase the resilience of agricultural production systems and improve resource efficiency (i.e. water and nutrients) (Marongwe et al., 2012). Conservation agriculture is currently being promoted by the Government of Zimbabwe's Ministry of Lands, Agriculture, Fisheries, Water and Rural Development and FAO under the *Pfumvudza* programme (FAO, 2024) with support from NGOs, CIMMYT, ICRISAT (Marongwe et al., 2012; Scoones, 2014), Foundations for Farming

(a local faith-based organisation promoting Farming God's Way) ('About Us | Foundations for Farming', n.d.) among other organisations. The overall aim of conservation agriculture is to intensify sustainable crop production in Zimbabwean farming systems.

The Ministry of Agriculture's AGRITEX Department championed setting up conservation agriculture demonstration plots across the country (Marongwe et al., 2012). As agricultural extension was integral in implementing and adopting conservation agriculture in Zimbabwe (Marongwe et al., 2011) this saw over 600 agricultural extension officers trained in 2009 through an FAO coordinated training programme (FAO, 2009). A conservation agriculture module was launched in 2010 to ensure students graduating with a Diploma in Agriculture from colleges are equipped with the correct information as they venture into their careers in agricultural extension (Marongwe et al., 2012). Inadequate capacities in farmers and extension, a need to train extension staff in conservation agriculture and machinery used to avoid problems encountered by farmers were highlighted as some of the challenges which hindered adoption. Apart from the need to equip extension with relevant information, it remains unclear if extension officers were equipped with skills to meet the needs of different farmer social groups practising conservation agriculture and newly resettled farmers whose needs centre on markets information, brokering (between farmers, service providers, contractors etc.) and business management skills (Scoones, 2014).

Integrated Soil Fertility Management is a nutrient-smart technology which encompasses the use of combinations of mineral micronutrient fertilisers, locally available organic nutrient resources and legume-cereal rotations to increase soil productivity in smallholder farming systems (Mtambanengwe & Mapfumo, 2005; Vanlauwe et al., 2015). Integrated soil fertility management complements conservation agriculture in the sense that it promotes crop rotations. Integrated Soil Fertility Management was widely promoted by the Soil Fertility Consortium for Southern Africa (SOFECSA) in early 2000 using Participatory Action Research on field-based Farmer Learning Centres (Mapfumo et al., 2013). In their study to assess factors influencing access to ISFM information and knowledge and its uptake among farmers, Gwandu et al. (2014) highlighted that government-employed agricultural extension agents were the most preferred sources of information by >90% of the respondents. The inclusion of ISFM and conservation agriculture in extension training and the availability of technical guidelines on the

prioritisation of ISFM technologies (Nezomba et al., 2015b) could ensure adoption of emerging technologies by farmers whose needs have evolved from mere crop production for subsistence to market-oriented and land preservation production.

2. MATERIALS AND METHODS

2.1. The RAELL Project: Agricultural Extension Skills Development Gap and Needs of Farmers

The Reimagining Agricultural Extension through a Learning Lens (RAELL) project was designed to bring together critical partners with strong links in higher and vocational education and national agricultural systems in the United Kingdom, South Africa, Uganda and Zimbabwe. The RAELL project connected North-South research networks to explore how the preparation and ongoing training of agricultural extension officers (AEOs) can be strengthened by linking them with training providers and their curriculum. RAELL was a short-term project which ran between December 2020 July 2021 with an overall aim to support the transformation and strengthening of a vocational education system that trains and educates agricultural extension officers so that they can better support a range of actors in the agricultural system. The project focused on how training for agricultural extension officers could positively impact food security, community resilience, and gender equity and address the causes and consequences of environmental degradation and climate change. RAELL (Vet Africa 4.0, 2019) was designed to address the following objectives:

- (1) Review existing research and grey literature on agricultural extension and its role in the agricultural system.
- (2) Identify all the key role players interacting with extension (actual and potential).
- (3) Understand the changing nature of extension work (focusing particularly on Conservation Agriculture as a case study).
- (4) Identify all relevant programmes and qualifications and analyse their official curriculum with respect to extension.
- (5) Make recommendations based on the analysis for how the skills development system can better prepare and continuously develop AEO skills.

This paper addresses objectives 1 and 3 of the project by reviewing the literature on the evolution of agricultural extension in Zimbabwe and identifying gaps between agricultural

extension and the needs of farmers and emerging technologies from a series of stakeholder interviews.

2.2. Stakeholder Interviews

A questionnaire on changes in roles and purpose of AEOs, curriculum training gaps and knowledge flows and functions of AEOs was drafted and administered during interviews with stakeholders in agricultural extension. Interviews were conducted face-to-face between June and July 2021, while others were conducted online in compliance with the COVID-19 protocols. Occupational Role Profiles were also accessed online from government, non-governmental organisations and private sector websites in June 2021. Occupational role profiles were accessed for a Government/ Ministry of Agriculture supervisor (N=1), Ministry of Agriculture crop and livestock AEO (N=2), Private sector (i.e. Tobacco and Small-scale) AEO (N=2) and NGO (organic farming) AEO (N=1). Findings from Occupational Role Profiles were presented in detail in the Zimbabwe-RAELL report (Manzeke-Kangara et al., 2021) and will not be presented in this paper. Stakeholder interviews were conducted with 22 participants comprising farmers, AEOs, individuals who train AEOs (i.e. lecturers from Universities), other agricultural extension implementors (i.e. working in the Ministry of Agriculture, Division of Extension and Division of Research) and institutions involved in agricultural extension curriculum and policy. The data set comprised recorded interviews and accompanying field notes for farmers (N=9), AEOs (N=5), individuals that train AEOs (N=3), other agricultural extension implementors (N=3) and agricultural extension policymakers (N=2) (Figure 4). Field notes were completed at the end of each interview.

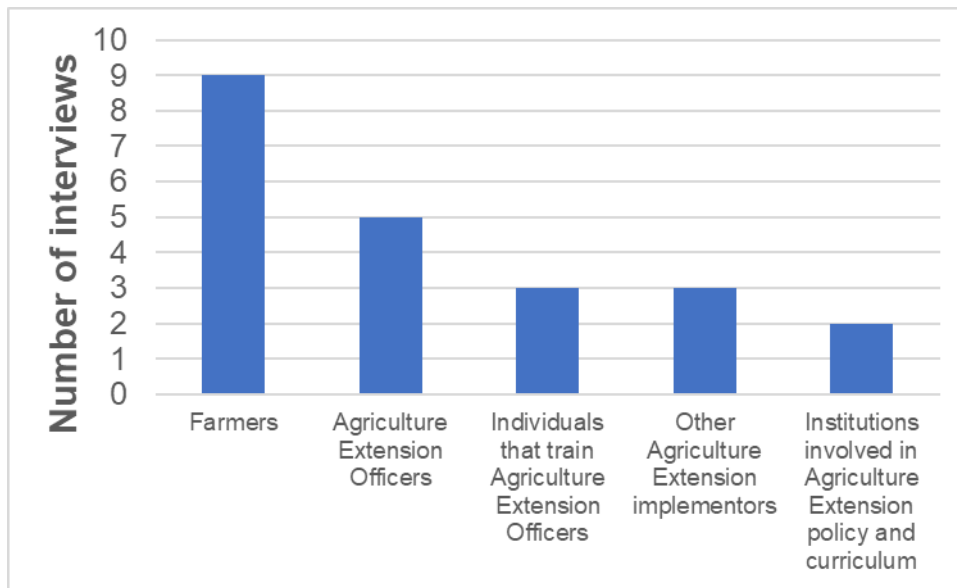


FIGURE 4: Type and Number of Interviewed Stakeholders (N=22).

2.3. Data Analysis

Data analysis was conducted for question 6 of the “Training gaps in formal training /curriculum” questionnaire from the RAELL questionnaire (see Supplementary files). Agricultural extension training needs were put into the following five categories as informed by background knowledge and from literature:

- (1) Socio-cultural issues
- (2) Information availability
- (3) Information and Communications Technology
- (4) Curriculum development
- (5) None (Participant did not say/ mention)

A tally method was used to score the number of participants who mentioned the above training needs. The tallies, converted into a percentages, were used to analyse the data and rank different stakeholders’ perspectives on training gaps in formal training/curriculum. Ranking and prioritising training gaps was based on the number of tallies attained for each training need. A word cloud of analysed text from the 22 field notes was generated using Monkey Learn and presented as supplementary information.

3. RESULTS

3.1. Farmers

The results per participant category show that 13.6% of farmers identified training needs and information availability on horticulture production, chemical use, markets, and climate change. The training need was indicated depending on whether the farmer wanted to be trained in crop or livestock production. For crops, some farmers indicated they might want to venture into new enterprises such as growing horticulture crops, such as potatoes (*Solanum tuberosum*). If the farmer is venturing into such enterprises for the first time, new knowledge and skills are required to produce cash crops. The absence of potato producers in some irrigation schemes where respondents were interviewed was attributed to a lack of knowledge. Maintenance of the field drainage system, climate change impacts on crop production, and the importance of indigenous knowledge of the value and resilience of traditional crops were some of the training needs highlighted by the farmers. On livestock production, needy areas centred on livestock farming, new knowledge on constructing cattle pens and managing livestock pests and diseases. Farmers also indicated they may need training in paddocking so that their grazing becomes more organised, as well as haymaking for adequate feed provisions during the dry season.

About 5% of farmers mentioned information and communication technology training needs. In this case, the farmers indicated the need for training in the use of technology, such as satellite monitoring of fields, as well as scientific methods for applying fertilisers in the right quantities and at the right time. Another 5% indicated the need for curriculum development. Regarding horticulture, some farmers indicated that the agriculture curriculum should be more comprehensive to cover scientific and traditional knowledge. This would allow the AEOs to be flexible and train farmers, for example, in horticulture production if the farmers want to venture into horticulture production. Notably, from this category of participant stakeholders' interviews, almost 13.6% of the respondents did not mention any specific training needs (Table 1).

TABLE 1: Training Needs of AEOS Identified in the Interviews and Their Ranking

	Training need	Number of participants who mentioned (n=22)	Proportion (%) (n=22)	Category ranking	Overall ranking
1. Farmers	Socio-cultural issues (i.e. gender disparities in agricultural extension)	-	-		-
	Information availability (i.e. markets availability, on new technologies, horticulture production, value addition, climate change, chemical use and calibration)	3	13.6	1	2
	Information and Communications Technology (i.e. use of mobile phones, real time weather information)	1	4.5	2	4
	Curriculum development	1	4.5	2	4
	Did not say/ mention	3	13.6	1	2
	2. Agricultural Extension Officers	Socio-cultural issues (i.e. gender disparities in agricultural extension)	1	4.5	2
Information availability (i.e. markets availability, on new technologies, horticulture production, value addition, climate change, chemical use and calibration)		0	0	n.a	n.a

3. Individuals that train Agricultural Extension Officers	Information and Communications Technology (i.e. use of mobile phones, real time weather information)	0	0	n.a	n.a
	Curriculum development	4	18.2	1	1
	Did not say/ mention	1	4.5	2	4
	Socio-cultural issues (i.e. gender disparities in agricultural extension)	0	0	n.a	n.a
	Information availability (i.e. markets availability, on new technologies, horticulture production, value addition, climate change, chemical use and calibration)	1	4.5	2	4
	Information and Communications Technology (i.e. use of mobile phones, real time weather information)	0	0	n.a	n.a
	Curriculum development	3	13.6	1	2
4. Other Agricultural Extension Implementers	Did not say/ mention	0	0	n.a	n.a
	Socio-cultural issues (i.e. gender disparities in agricultural extension)	0	0	n.a	n.a
	Information availability (i.e. markets availability, on new technologies, horticulture production, value addition, climate change, chemical use and calibration)	0	0	n.a	n.a
	Information and Communications Technology (i.e. use of mobile phones, real time weather information)	1	4.5	2	4

**5. Institutions
 involved in
 Agricultural
 Extension
 Policy and
 Curriculum**

Curriculum development	2	9.1	1	3
Did not say/ mention	0	0	n.a	n.a
Socio-cultural issues (i.e. gender disparities in agricultural extension)	0	0	n.a	n.a
Information availability (i.e. markets availability, on new technologies, horticulture production, value addition, climate change, chemical use and calibration)	0	0	n.a	n.a
Information and Communications Technology (i.e. use of mobile phones, real time weather information)	0	0	n.a	n.a
Curriculum development	2	9.1	1	3
Did not say/ mention	0	0	n.a	n.a

n.a = not applicable.

3.2. Agricultural Extension Officers

For the second category of participant stakeholder interviews comprising Agricultural Extension Officers (AEOs), 18.2% indicated the training needs concerning curriculum development. The high ranking for-curriculum development was attributed to the value given to the diffusion of knowledge and information on issues relating to both crops and livestock. Regarding livestock, AEOs indicated that for Veterinary Extension Workers. However, their field involves training in basic livestock management; additional knowledge would be required in meat inspection and skills to identify and separate good meat that is fit for human consumption and that which is not. The veterinary extension workers would also need training in the growing of fodder crops and managing hay to feed cattle in the drier areas of the country.

Regarding crop production, AEOs indicated training needs related to the use of chemicals, herbicide management, and pest control. Training was also needed in sustainable practices such as the use of solar energy and horticulture production. Refresher courses were also indicated to be required in climate change as the seasons were changing, and extension was needed to advise farmers accordingly. About 5% of AEOs mentioned addressing socio-cultural challenges within agricultural extension, such as gender disparities. Agricultural extension is dominated by male advisors, which potentially offset the socio-cultural dynamics in smallholder farming systems where women farmers would preferentially want to receive advice from female extension officers.

On the other hand, household heads might prefer their wives to receive advisory services from male AEOs in their presence. These socio-cultural dynamics are crucial and ought to be addressed for crop production success. The remaining 5% of the respondents did not mention specific training needs.

3.3. Individuals who Train AEOs

The results of the individuals that train AEOs show that their responses were mainly confined to two categories of training needs: curriculum development, which ranked the highest at 14%, and information availability ~5%. While there was a general appreciation that the curriculum for universities seemed quite comprehensive, concerns were raised about major curriculum gaps at certificate and diploma levels. It was highlighted that there was need for practical hands-on training for the graduates at these levels to meet farmers' expectations. Most colleges lacked

the equipment to provide practical training. As a result, most graduates leave the college without knowledge to perform basic hands-on activities, yet they are supposed to assist and/or demonstrate the activities to farmers. The gaps in the practical training relate to the use of new technologies and the availability of new knowledge. AEOs generally do not get training in terms of equipment calibration and the use of irrigation equipment technologies, yet these are required by farmers. As a result, they lack practical experience using the latest farm machinery and equipment. AEOs also indicated the need for training in digital systems such as the use of Geographic Information Systems (GIS) and land use planning using modern technologies. There was also an indication that the training of AEOs provided inadequate mathematical skills. Yet, these are necessary for effective extension for the extension worker to calculate animal doses for livestock, area, rates and volumes of fertilisers and chemicals to be applied. Information and Communication Technology (ICT) skills were also poorly covered in the curriculum.

3.4. Other Agricultural Extension Implementers

The next category of stakeholder interviews involved other agricultural extension implementers embracing private extension agents engaged by agro-service providers. At least 9% of the stakeholders interviewed indicated a curriculum development training need, while 5% prioritised information and communications technology, citing gaps in the training of extension workers covering livestock and crops. In terms of livestock production, the gaps in curriculum development indicated included fodder management and knowledge in producing livestock feed for local farmers, training in the management of local breeds that can withstand adverse conditions such as pests, diseases and nutritional challenges associated with climate change, and competencies in raising small livestock. Regarding crop production, training needs included capacitating AEOs towards the production of high-value crops such as garlic and other horticultural commodities, market intelligence, and knowledge and skills in water management and climate change mitigation. Stakeholders also indicated the need to train AEOs in a range of soft skills such as management of groups, participatory extension, networking, and innovation. Training in marketing was deemed important for AEOs to have more reliable marketing information as part of their extension package to farmers.

3.5. Institutions Involved in Agricultural Extension Policy

The last category of stakeholders' interviewees focused on institutions involved in agricultural extension policy and curriculum, where 9% identified training in curriculum development as a top priority. As the front-line staff in agriculture, AEOs are, in most cases, expected to have technical know-how. Preference was given to AEOs to train farmers in a wide range of activities in agricultural production, from land preparation, farm budgeting, planting, weeding, harvesting, post-harvest management, and product marketing. Additionally, interaction with AEOs was required in routine farm visits to monitor and evaluate crop and livestock activities on-farm. AEOs were also expected to provide information on the ideal crop varieties for different seasons, such as wheat in winter and other crop varieties in summer.

The institutions also indicated that the curriculum for AEOs should focus more on dryland agriculture for those who will operate in the drier agroecological regions IV and V. The curricula should also focus on traditional grains and sugar cane farming as these are known to withstand the drier environments which characterise regions IV and V. Value addition and processing of wild/indigenous fruits such as the African Marula (*Sclerocarya birrea*) should also form an important component of the training. Future training needs of AEOs should include precision agriculture, use of geographical information systems (GIS), remote sensing, climate change adaptation, and how innovations in target communities can contribute to national development.

On the farming-as-a-business concept, agricultural extension policy institutions also prioritised including finance and business aspects in the training curricula as most AEOs were uncomfortable handling these issues. Such training could be handled with financial institutions to ensure relevant topics are included and adequately delivered.

4. DISCUSSION

4.1. Closing the “Skills Gap”: The Need for Agricultural Extension Curriculum Reform in Zimbabwe

Curriculum development was ranked the highest by 100% of individuals that train AEOs' and institutions involved in agricultural extension policy and curriculum, 80% of AEOs, and 60% of other agricultural extension implementers. Internationally, the agricultural vocational education and training curriculum reform has gained prominence among policy makers and

academics. Agriculture is recognised as central to economic development and meet continuing challenges of poverty and hunger (Pawlak & Kolodziejczak, 2020). Increasingly, too, it is seen as an important element of responses to climate change. In this light, the problem of curricular misalignment has become widely accepted. This is the case in Zimbabwe, where important domestic contexts also have exacerbated the issue. There is consensus that the current curriculum was conceptualised and designed for a different Zimbabwe, which placed more attention on commercial farming and had few smallholder farming communities (Muwaniki et al., 2022).

The colonial heritage and restructuring of the agricultural extension system in Zimbabwe left loopholes and skills gaps, which resulted in a general inadequacy of the system in meeting farmers' needs (Zvavanyange, 2014). Since the attainment of political independence in Zimbabwe in 1980, there have been significant changes in the agricultural sector. Some have been due to land reform that opened farming to new categories of farmers as part of wider changes in the political economy. Changes in climate and the introduction of climate and nutrient-smart agricultural technologies such as conservation agriculture, ISFM including recent agronomy-based research for improved crop and human micronutrient nutrition (i.e. agronomic biofortification) (Manzeke et al., 2019) further expose inadequacies in the current agricultural extension system to promote such technologies. Hence, a more relevant and responsive curriculum is needed to address farmers' current and future needs.

At the global level, vocational education programmes in agriculture have been criticised for being narrow in scope and misaligned to the needs of the labour market, while those programmes in universities and colleges of agriculture at undergraduate level are too theoretical and not in line with the needs of small-scale farmers and employers (Vandenbosch, 2006; Wedekind & Mutereko, 2016). Curriculum challenges in agricultural education and training (AET) have also been noted globally. Freer (2015) argues that there is a need for curricula and pedagogical updates for AET systems to produce graduates with the knowledge, skills, and attitudes that enable sustainable food security, improve livelihoods, and facilitate natural resource conservation. Generally, the AET curriculum and pedagogy have been criticised as outdated and unable to serve the needs of agricultural learners and the labour market (Muwaniki et al., 2022).

More broadly, the call for a responsive VET curriculum has caught the attention of several researchers in Southern Africa (Gamble, 2003; McGrath et al., 2006; Wedekind & Mutereko, 2016; Muwaniki, 2020; Muwaniki et al., 2022). A responsive curriculum requires a rethinking of the nature of the curriculum, particularly of the relationship between the curriculum, everyday life and the world of work. For responsiveness to be achieved, there is a need to consider the needs of learners, institutions, the labour market, and policymakers (Wedekind & Mutereko, 2016; McGrath et al., 2020). AET curriculum reform in the Zimbabwean context should ideally respond to the negative impacts of climate change, diminishing levels of soil fertility and developments in technology and global market demands.

4.2. E-Extension for Changing Farmers' Needs and Emerging Agricultural Technologies

The FAO (2023) report mentioned farmers' limited access to knowledge and best practices as one of the key agricultural challenges threatening productivity in Zimbabwe. E-Extension encompassing electronic technologies such as radio and television, videos and mobile phones to enhance/ complement traditional extension approaches (such as written and face-to-face meetings) could bridge this knowledge gap (Global Forum for Rural Advisory Services[GFRAS], 2022). E-Extension/Information and Communication Technology (ICT) use in agricultural extension and advisory services is recommended by FAO (2017) and Mapiye et al. (2021) as it is beneficial in serving farmers with timely information which can lead to behaviour change (Bell, 2015). In our study, the use of ICT was mentioned as a training gap by farmers and other agricultural extension implementors, ranking 2nd in both stakeholder categories. Media (i.e. radio, television and newspaper) is widely used as a source of agricultural information in Zimbabwe (Mugwisi, 2015). However, some farmers are still deprived of information on new technologies, weather forecast, value addition and market access. The use of mobile phones has been on the increase in Zimbabwe where, according to DataReportal, the number of mobile connections in Zimbabwe in January 2021 was equivalent to 98.5% of the population, with a significant proportion having more than one mobile connection (Data Reportal, 2021). This figure was up from 87% of households who owned a mobile phone during the 2015 Demographic and Health Survey (DHS) and up from 62% during the 2010-11 DHS (ZNSA/ICF, 2016). Tapping into increased usage of mobile phones so that they are used as platforms for knowledge and information dissemination, rather than mere

gadgets for communication, can complement traditional extension approaches. This can consequently result in improved crop productivity in areas where extension:farmer ratios are high and poor road networks, weather challenges or emerging pandemics restrict access.

New technologies to curb the effects of climate change and poor nutrition, such as conservation agriculture and agronomic biofortification are being promoted in rural farming systems in Zimbabwe (FAO, 2009; Manzeke et al., 2014; Mbanyele, 2021). For example, since 2020, the Government of Zimbabwe is currently rolling out the *Pfumvudza* Programme, a concept based on maximising conservation agriculture principles to have higher returns through intensification of crop production systems and strengthening the resilience of farmers to climatic shocks (FAO, 2024). Before this, a National Food Fortification Programme was launched in 2015 to industrially fortify staple foods with essential micronutrients (www.unicef.org/zimbabwe/media). Despite widespread research efforts and documented outputs in conservation agriculture, stakeholders interviewed in this study reported a lack of information and knowledge in this domain.

Through e-vouchers for agricultural inputs covering seed and fertiliser, and e-Extension, ICT has been successfully used to promote conservation agriculture in Zambia (FAO, 2020). The Global System for Mobile Communications Association (GSMA, 2020) recommends access to information such as weather forecasts and agro-climatic advisory through the incooperation of localised agroclimatic weather information by smart advisory providers such as Econet's Ecofarmer (Mago, 2014; GSMA, 2020) platform. Timely availability of local weather information could substantially contribute to building the resilience of smallholder farmers to climate change shocks.

Localised weather and market information for farmers and advice on on-farm income-generating activities, such as horticulture production, can also be included on smart advisory platforms. Mobile phones are important in accessing information on commodity prices, which could motivate farmers to produce crops of market value in addition to subsistence production. One participant in the interviews mentioned the need to include economics topics in formal training so that farmers know production costs and enterprises which generate income from local and export sales. In addition to including economics topics in the agricultural extension curriculum, smallholder farmers can be assisted with access to local market information on their

mobile phones. This will enable farmers to generate income from crop production and enhance their purchasing power of off-farm nutrient-dense produce such as meat and fruits, which improves their diets and social security.

5. CONCLUSION

Zimbabwe has a long history of the evolution of agricultural extension, with institutional changes and modes of extension shaping the current state of this essential agricultural production service. Rapid institutional changes in agricultural extension in the country left this core agricultural production service falling short of meeting the needs of emerging technologies such as conservation agriculture, ISFM and agronomic biofortification), and pending impacts of climatic change, particularly for new farmers. Relevant and responsive agricultural advisory services are required to potentially meet the changing roles of agricultural extension officers and the evolving needs of new farmers who are more inclined towards high-value agricultural production for marketing. Findings from our study reported an urgent need for Agricultural Extension curriculum reform and the the availability of information on markets and the adoption of new technologies, including the use of chemicals in high-value crops. Therefore, agricultural extension curriculum reforms and increased use of ICTs including e-Extension are needed to promote the adoption of new technologies and to meet emerging needs of farmers to bridge the existing Agricultural Extension skills gap in Zimbabwe.

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DATA AVAILABILITY

Data is available from authors upon reasonable request.

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Appendices



DIAGRAM 1: Word Cloud From 22 Field Notes of Interviews Conducted in Zimbabwe.

TABLE 1: Questionnaire for Stakeholder Interviews

Question on:	<i>Explanation / examples</i>
Q1: What is the role and purpose of AEOs arising from the data? Is this changing over time?	
Definitions / expectations of AEOs	<i>E.g. different stakeholder perspectives on the role and purpose of AEOs</i>
Q2: Is teaching/training/social learning recognised as a core function of AEOs?	
Teaching / training / social learning IS recognised as a core function – general references	<i>Teaching/training/social learning recognised as a core function of AEOs, e.g. by AEOs themselves, by others.</i>
Teaching / training / social learning IS NOT recognised as a core function – general references	<i>Teaching/training/social learning is clearly not recognised as a core function of AEOs, e.g. by AEOs themselves, by others.</i>
Q3: Formal training of / curriculum for AEOs: what is working, training gaps, areas for improvement?	
Source of formal training?	<i>E.g. training institute, university, professional development courses</i>
What is working - examples	<i>Examples of formal training that seem effective – either pre- or in-service</i>
Training gaps in formal training /curriculum	<i>Evidence of gaps in formal training, .</i>
Areas for the improvement of formal training	<i>Suggestions for changes to curriculum, training system</i>
Q4: Knowledges to AEOs in daily practice	
Source of knowledge flows to AEOs in daily practice	<i>E.g. formal training institute, informal network, farmers, other stakeholders etc</i>
Medium / tools	<i>E.g. website, newspaper, radio, training workshop</i>

Type of knowledge: Agricultural knowledge	<i>E.g. types of scientific and agriculture knowledge</i>
Type of knowledge: Contextual knowledge	<i>E.g. community knowledge, understanding of the social context, culture etc</i>
Type of knowledge: General educational knowledge	<i>E.g. teaching skills, pedagogic understanding, knowledge of learning needs</i>
Knowledge of specific topic / challenges	<i>E.g. climate change, small-scale farmers etc.</i>
Exemplars that illustrate the dynamics of AEO learning	<i>E.g. where and who AEOs learn from? Farmers, colleagues, scientists, books, radio etc</i>
Q5: Knowledge flows and functions of AEOs in daily practice (Shaxon et al., 2011)	
Target (of AEO knowledge transfer/teaching/social learning)	<i>E.g. who are AEOs 'teaching' or collaborating with in learning contexts: farmers, scientists, colleagues, policy makers?</i>
Information Intermediary	<i>Enables access to knowledge e.g. connects people, suggests resource etc</i>
Knowledge Translator	<i>Helps people make sense of knowledge, helps apply knowledge, collates knowledge</i>
Knowledge Broker	<i>Improving knowledge use and application, co-creates knowledge, e.g. working out a solution to a problem with a farmer</i>
Innovation Broker	<i>Influence wider use of knowledge, facilitating innovation, system integration, feedback to scientists, training institutes, where impact is on the system</i>
Topic (of AEO knowledge)	<i>Context specific challenges e.g. climate, small-scale farmers</i>
Exemplars that illustrate the dynamics of AEO knowledge flows and functions	<i>Examples that illustrate the main roles that AEOs are playing in terms of knowledge sharing and mediation?</i>
Q6: AEO knowledges, teaching and social learning skills required from a RAELL perspective (futures perspective)?	

From farmers perspective	<i>Knowledges, teaching, social learning required for AEOs in future from a RAELL perspective according to key stakeholders . E.g. related to new and emerging issues such as climate change, new technologies, new methodologies of teaching and learning etc.</i>
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