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Agricultural Water Demand and Supply, Governance, Conservation, and Implication for ExtensionServices in South Africa: A review

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Abstract

Pragmatic changes existed within the regulatory structures and institutionsfor water resource management in South Africa since 1994. The paper examined the trajectory of agricultural water demand and supply, governance, conservation, and implication for extension services. Prominent institutional repositories were consulted for this review including scientific materials obtained from the online library of various universities by engaging in Online Public Access CatLog (OPAC), Cat Plus and Digital Collections, and numerous scientific papers and grey literatures. However, the study answered the following questions:(i) Are there water demand and supply issues in South Africa? (ii) What are the water conservation approaches used in South Africa? (iii) What are the implications of water management for agricultural extension service in South Africa? The review nurtures government confidence in ameliorating management issues and recommended changesto address the financial, environmental, and capacity limitations inherent in water sector. Though the sector has witnessed considerable improvement since 1994, the performance of the sector in relation to its objectives have not been encouraging. The distribution of water for agriculture and industrial uses are still highly uneven with vagueness and lack of transparency with respect to institutional roles and responsibilities. The paper, therefore, endorse the up skilling of farmers to minimizing the negative environmental impacts of irrigation, reducing the production cost, and enhance the sustainability of irrigated farming in South Africa. Government and extension should do more to support and conscientize farmers towards appropriate irrigation systems aimed at minimizing water losses. There is a need for sustained efforts to manage existing water infrastructures by all stakeholders for the benefit of the farming communities.

Keyword: Agriculture,water demand and supply, governance, conservation, implication, extension services, challenges, resources

INTRODUCTION

Agriculture remains themost important sector of the economy of most non-oil exportingcountries in Sub-Saharan Africa. Agriculture constitutes approximately 30 percent of Africans GDP and donates about 50% of the total export value, with 70% of the continents population depending on the sector for their livelihoods. However, agricultural productionthrive at subsistence level(Maponya and Mpandeli 2013).The debate on water availability, climate change and its impact on agriculture is therefore, very crucial to the survival of the continent and its people. Water is vital for all socio-economic development and for maintaining healthy ecosystem. With increase in population, the utilization of groundwater and surface water for domestic, industrial and agricultureincreases, leading to tensions, conflicts between users, and extreme pressure on the environment (Khan, 2014).Food policy must not lose sight of surging water scarcity as water remain a fundamental portion of the environment, an asset, whose quality decides the nature of its utilization. Water is a limiting asset for development in South Africa and alteration in water supply may have major implications in most sectors of the economy, particularly the agricultural industry (Pengelly *et al.*, 2017; Aither 2018).Substantial evidence existsin physical and economic spheresto prove that South Africa is a water

scare country (Mnisi, 2020). South Africa is classified amongst the thirty driest nations globallydue to variation in climatic condition and escalating water demand (Mabhaudhi*et al*., 2019). The rainfall pattern in South Africa is unpredictable and unevenly distributed across the country.However, water resources are required to strengthen all agricultural activities including mining, and other social and economic spheres in both rural and urban areas of the country (Agholor, 2013). The shortage of investment in water infrastructure and inadequate technological skills to draw adequate water from streams and various water sources has been a major contributing factor to water scarcity nationally. Many factors such as inadequate precipitation associated with increased evaporation rates and rapid population growth have also contributed to the existing water shortages in South Africa. However, this situation is unlikely to improve because of the existing patterns of water usage and management (Bwapwa 2018). The DEA (2013) also agreed that there is an expected increase in the demand of water which is associated with the current economic development, increased expansion, advanced living standards and population growth. The negative impacts of climate change could therefore worsen the present challenges in relation to water availability and distribution.It has been a major concern for the South African government to ensure fair and adequate water services to all citizens of the country in the past decade. Therefore, for sustainable economic growthin water sector, the human and technical elements must be constituted to address the complexity in water management (Weaver,Keeff, Hamer and Palmer 2017). In South Africa, thesustainable hydro-resources are currently over-exploited,and a larger portion of the country's hydraulic structures has deteriorated and water levels in dams are minimal (Donnenfeld *et al.* 2018). The 2014 to 2016 drought incidence in South Africa highlighted the existing weaknesses in the country's water schemes and it accurately exposed the enormity and significance of safeguarding the country's water security.

In South Africa climate change haveposed a considerablethreat to the country's water resources, availability of food, human well-being, ecological services,infrastructure, and the natural environment.Most rural communities have experienced the reality of water scarcity and shortages as most of them rely on rain-fed agricultural activities. Small scale farmers cannot afford to purchase the advanced tools required for extraction and conservation of water for their household and agricultural needs, yet the agricultural sector is liable for major livelihood activities.The availability of water is considered as the main input for agricultural production, therefore inadequate supply of water could lead to failure of agricultural production and itsattendant food insecurity (Hristov 2014).The review paper dwells on the stratagems including extension services to support the knowledge areas in water demand and supply, water governance, conservation and management of water resources must be put in place. The involvement of extension will assist in creating awareness and knowledge brokerage on the issues of climate change, building resilience capacities, and encourage participation of all stakeholders in addressing water management. The review paper attempts to assess and examineextensively agricultural water demand and supply, water governance, water conservation and implication for extension services.

METHODOLOGY

In search for suitable literature for the paper, the hunt criteria adopted by the authors were as follows:(i) papers to be reviewed were selected ifwritten in English (ii) papers, journals, book and book chapters used,only emphasis the theme on water management was used (iii) literature search was diverse and not restricted to journal articles (iv) grey literatures were also considered for the review paper and relevant keywords were besought from the databases and search engines-Web of Science (WoS), Science Direct, Scopus, SciELO, Microsoft Academic, Research gate and Google Scholar (GS). Prominent institutional repositories were consulted to review papersincluding many scientific materials obtained from the online library of various universitiesby means of engaging its Online Public Access CatLog (OPAC), Cat Plus and Digital Collections; and numerous scientific papers and hoary literatures published over 10 years back were carefully chosen for use. However, the study answered the following questions:(a) Are therewater demand and supply issues in South Africa? (b) What are the water

conservation approach used in South Africa? (c) What are the implications of watermanagement for agricultural extensionservice in South Africa?

DISCUSSION

The approach adopted to answer theresearch questions as indicated in the methodology consisted of both extensive literature review and analysis of past presentations (Mutiro and Lautze 2015).Water management issues in South Africa were precisely highlighted and its implications for agricultural extension was extensively discussed. The review also examined the local water resilience strategies adopted by farmers to boost agricultural output. Results have shown that despite the current water scarcity and fluctuating rainfall pattern due to climatic change, there are possibilities of restoring the water problems in South Africa. The restoration can only be successfulthrough significant monetary investments and political intervention.

Water demand and supply in South Africa

The continuous growth of population worldwide, coupled with an increasing need for food as well as the necessity to protect ecological environment has provokedthejudicious utilization and administration of the available resources tocater for the high demands for food availability (Maisonet- Guzman 2011). Therefore, if the need of conserving the available water resources is not realized, there may be instances whereby the available soil and water resources will not be adequate to support life on the planet. Soil and water should thus be considered as living objects, as it supports plants, and provides shelter to animals. Sustainable use and conservation of soil and water resources is not solely of crucial important for farming activities but alsofor the sustenance of the entire mankind (Bashir et al. 2017).

Water plays a vital role in sustainable livelihoods, development, and economicgrowth thus water scarcity has led to more competition amongst various water users (Unger, Kirkham & Nielsen 2010). As previously stipulated, the agricultural sector is the largest user of water in the Republic of South Africa (RSA). Therefore, water shortages can result to massive losses in the agricultural sector leading to economic instability,development, and food insecurity (Unger *et al*. 2010).The total water extracted for human purposes globally, an average of about 70% of that water is used for agricultural activities, while 20% is used for industrial purposes and 10% of the water is directly used for human consumption (Creamer Media' s Report 2012). Moreover, the water demand in South Africa is expected to exceed the supply by 17% by the year 2030 (Green Cape 2019)

Household sector

Water demands for most household has increased with increase in population and household sizes. Household size isconsidered toinfluence the use of domestic water, whereby water availabilitydeclines as the household size increases. Prolonged increase in temperatures and household income also contribute to the high domestic water demands. Avariety of alternatives has therefore been put in place in trying to control and manage domestic water utilization. These include the upward tariff adjustment, public alertness, controlling of water loss by identifyingand repairing leakages and burstspipes.To minimize water consumption the public has been encouraged to use water- efficient machines such as dish washers, washing machines and shower filters (Powertech 2012).

Industrial sector

The deterioration of the quality of most surface water are attributed tothe effects of mining with effects on industrial, and domestic water consumers (Ochieng, Seanego&Nkwonta 2010). Rapid growth is relatively expected in the mining industry with increased demands for water consumption required for exploration of minerals especially in the northern regions of the country (Ochieng *et al*. 2010).To assuage the situation, proper metering has been the most effective tool in controlling water demand in industries. Necessary documents that control both local and industrial water consumption has been issued in relationsto the Water Acts. These documents' guiding principles stipulate the measuring of water volume to each user by

means of water meters, which guarantee effective water consistency and accessibility.

Agricultural sector

Water use varies from domestic use and stock watering, industrial, mining, power generation, and irrigation. Many sectors water-use differ but irrigation is by far the largest consumer of water (Figure 2).

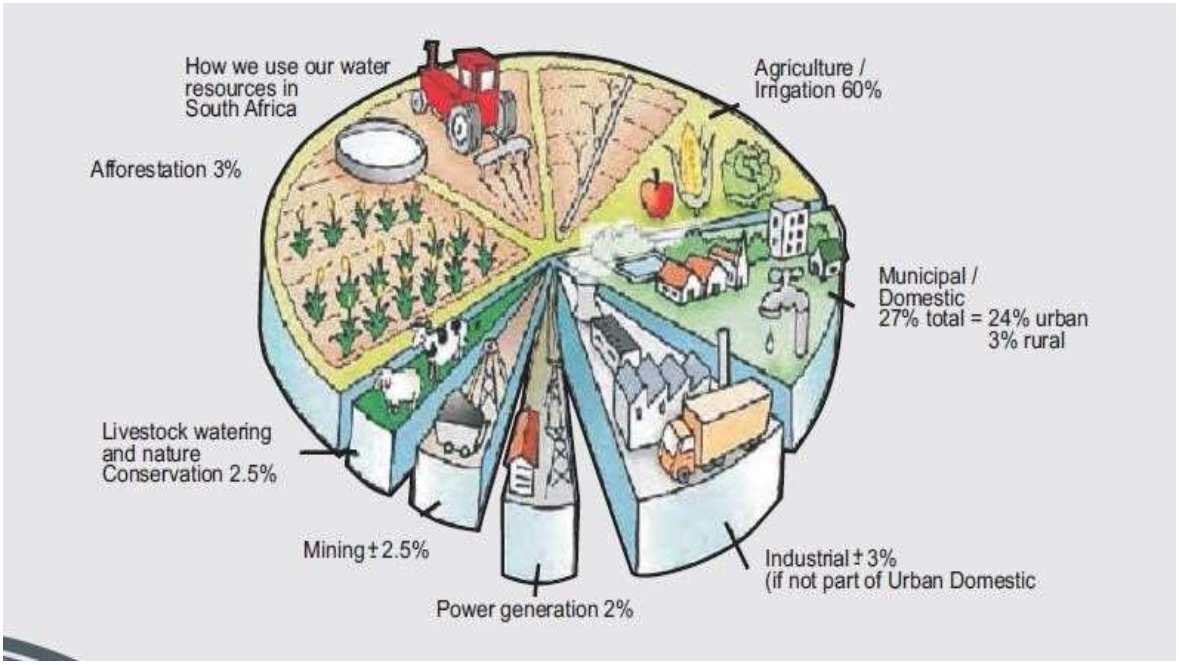

Figure 17: Relative use of water withdrawals per sector

Irrigation is certainly the major user of ground and surface water resources nationally with a determined volume of approximately 60% of the available water in the country. Althoughthe agricultural sector utilizes a major share of available water in the country, its economic contribution is relatively smaller than other sectors when compared to the total volume of water used (Our news 2018). Various measures haveconsequently been put in place in trying to manage and control the increasing water demand in this sector. For instance, to ensure famers are water-smart, the latest agricultural online tools and technologies are providedat farm level. Farmers have begun to shareremediation of water risks upstream, for example with the removal of invasive plants and introducing water awareness's in downstream communities has assisted in conserving water resources (Our news 2018).The South African government has also played a significant role in regulating and managing water use. This has been done through the irrigation management transfer (IMT) which entails giving the responsibility of operating, managing, and maintaining irrigation schemes to farmers.In addition, improvementof knowledge on crop water requirements in relationto irrigation scheduling has played a noticeable role in boosting crop harvest produced for every unit of water used. Smallholder farmers use various water conservation methods which include rainwater harvesting, mulching, growing of more water efficient crops in relation to regional climate and using of drip irrigation methods (Green Tumble 2016).

Water management strategies

There are numerous Acts and policies that assist in the management of water resources in South Africa. National Water Act and National Water Resource Strategy outlines plans for managing water resources, preparing catchment management strategies, assisting in the provision of water related information andidentifying development opportunities (DWAF, 2010). At the cusp of the hand over to the new government in 1994, the Reconstruction and Development Programme (RDP) was initiated which was based on five main programmes: to meet the essential needs of the people; develop the human resources;

democratised the state and society; build the economy and implement the RDP. In south Africa, the Bill of Rights are important for the management of water resources as indicated in section 24 and 27 of the Bill of Rights, which specify that all persons have the right to access sufficient food and water, and everyone has the right to conducive environment (DWA, 2013a). The Department of Water Affairs (DWA) oversees managing all aspects of the National Water Act while the Catchment management Agencies (CMA) which represent the second-tier water management saddled with the responsibility of comprehensive development and implementation of water resources. The 9 water management areas were established for efficient management of water resources (Figure 1).

Changes in temperature could result in reduction of runoff water particularly, in water scarce countries such as South Africa (Iglesias & Garrote 2015). Understanding water management strategies is therefore, a very important aspect of evolving mitigation and adaptation strategies to water scarcity in agriculture as the impacts of climate are gradually transforming the nature of current water security. Variation in climatic conditions and persisting drought occurrences further increases the complexity of water management. Water management strategies in agriculture involve the application and use of a variety of infrastructure and equipment (Iglesias & Garrote 2015). The short-term water management responses can be referred to as managing strategies, while long–term actions which assist in dealing with future inconsistency could collectively be referred to as the adaptation strategies (Garcia de Jalon, Iglesias & Diaz 2014).Water management strategies in agriculture needs to be viewed in relation to the increased scarcity of water most especially during farming. Building resilience to the increasing scarcity of water nationally can assist in reducing water constrain amongst farmers as well as natural ecological environment.

Figure 15: Nine water management areas in South Africa

The South African government justifies a remarkable reference on how developing countries can positively influence integrated water resource management (Hassan 2011). Lack of local capacity to implement water management has been identified as the greatestproblem in South Africa.Research has indicated that lack of qualified water managers

in various municipalities has resulted to the inability of these municipalities to comply with provision of quality standards of water management (Hassan 2011). In addition, inadequate funding allocated for water managementand high administrative cost is also amongst the major challenges of water management.

Water resilience strategies

In most developing countries Resilient Agricultural Practices (RAP) is regarded as a crucial element for sustainable food systems and security (Sawicka 2019).The study by Agholor & Nkosi, (2020) found that the degradation of land and water resources will ultimately jeopardize environmental and agricultural sustainability in South Africa. In addition, the study opined that neglecting appropriate water resilience strategies and conservation practice, will amount to food shortages and loss of farm income. Owing to erratic climate events, the adoption of suitable water management techniques has become a national development policy discourse for South Africa, notably as an avenue to mitigate food insecurity.The Food and Agricultural Organization (FAO) has worked together with farmers to make more proficient cultivation frameworks through the Integrated Production and Pest Management (IPPM). This assists farmers in seeing how farming practices can conserve water and supplement resilience strategies aimed at water management (FAO 2020).To ensure improved water management, various Climate Resilient Agriculture (CRA) practices are currently put into practice by farmers especially in aquaculture systems, vegetable and animal production, integrated farming systems and rice as well as maize production (Patle, Kumar & Khanna 2019). Nevertheless, the utilization of CRA practices is currently limited in most countries due to inadequate access to better quality seeds, limited financial incomes required for investment and inadequate resources (Patlev*et al.* 2019).The cultivationa range of agricultural products for food can assist in alleviating poverty and ensured food security(Frison, Jeremy & Hodgkin 2011). Robbins and Colt (2012)affirmed that the production of various varieties of crops that have shorter maturing period assist in water conservation; and is amongst the strategies currently adopted by farmers to conserve water in most water scarce regions. These CSA practices involve weed control measures, reduction of soil erosion and reduction of soil moisture content loss through conservation tillage, growing of stress resistant varieties and change of planting dates (Maya 2018). Although these climate change adaptation practices have been recommended by most researchers and scholars, but it is associated with both costs and benefits. Costs required during the implementation of these strategies range from purchasing drought resistant seeds and purchasing of irrigation equipment.However, the benefits of CSA include reduced climate change impacts with new opportunities embedded in the use of CSA practices (Elum, Modise & Marr 2016).

Water challenge in farming

In sub- Saharan Africa, the agricultural sector remains the major source of employment and has a significant role on food security and income generation (Agholor 2019). Studies has shown that small holder famers contribute about 80 percent in agricultural produce in Near East and North Africa (NENA) to the economy. This therefore reflects that farming activities of smallholder farmers assist with food security in the region (Lewis, Monem&Impiglia 2018). Water challenges occasioned by climatic changes affects livelihoods of vulnerable and marginalized farmers. They have become more at risk as they directly depend on natural resources for their livelihoods and are usually detached from resources, social defense schemes, markets, and extension services (Lewis et al. 2018). The major effects of the continuous change in climatic conditions affects water supply schemes and gradual increases water uncertainty, which thus complicates water management supplynationally. The impacts of climate could possibly worsen the current water-related challenges and through the continuous variability in precipitation and life-threatening weather events (floods and droughts) new dimension to the challenges could manifest. Climate change has also resulted to sudden changes in rainfall seasons and increased temperatures resulting to more water losses through evaporation (DEA 2013).

In South Africa, the agricultural subdivision is considered as the main water user. This sector

accounts for about 60% of water demand nationally. Water accessibilityis therefore, a major limiting aspect in agricultural production and limited water qualities could have negative effects to agricultural income and exports (Ashton 2000). Many municipalities have been blamed for water restrictions and their inability to limit water wastages because of deprived infrastructure (Ashton 2002). It is argued that the weakening abilities of government to supply enough quantity of safe and clean water to communities increases the potential for instability and political conflicts (Jankielsonhn 2018). Water resources required in sustaining communities can be amongst the main causes of political conflicts. This has been witnessed in South Africa whereby the failure of local governments to respond to water supplies has presently become a key source of service delivery disputes (Jankielsonhn 2018).Livestock production has contributed largely to the gross domestic products in the overall agricultural sector, and it accounts to about 48% of the total outputs in value terms in agriculture (GCIS 2015). In the past, severe drought which resulted in the death of about 40,000 cattle in Kwazulu-Natal may re-occur if no mitigating strategies are put in place in South Africa (Mare &Willemse 2015).Nevertheless, the natural grazing lands are currently being extremely depleted due to drought which has resulted in farmers undertaking distress sales of their livestock (GCIS 2015).In South Africa, various efforts, strategies, and policies have been implemented nationally to address water challenges in the country. For example, a huge quantity of dams has been built in the country and owing to variations in rainfall, canals have been developed to direct water to farming land, while farmers also have been encouraged to construct terraces to minimize runoff and to mulchand conserve water. They have also been encouraged to make contours as a water retaining method (Unger *et al.* 2010).

Water Governance

Prior to 1994, water governance in South Africa were branded by anarrow policyapproach patterned to the apartheidsystem with a lot of the citizens denied of legal water rights (Kranz et al., 2005; Seetal and Quibell, 2005). On the cusp of the handover to democratically elected government, the water law was completely revised and the White Paper on water policy which resulted in the promulgation of Water service Act and followed by National Water Act was put in place (Republic of South Africa, 1998; Herrfahrdt-Pähle, E. 2010).The managerial processes in which decision makers use in water governancevary from time to time. In South Africa, a lot of changes has occurred post-apartheid era with governing structures are in place. Water Act 36 of 1998were introduced in trying to protect, manage, conserve, and govern the available water resources in the country (Viljoen & van der Walt 2018). Efficient water protection, management and conservation strategies are the key element of reducing the current persistent water demands in the country. In addition, accountability, transparency, and involvement are vital approaches of good water governance. Though, their complication has resulted in debates on how essential issues such as how accountability should be approached and to whom project authorities and policy makers should be accountable to (Tortajada 2010).The country is not only inundated by the frequent severe drought problems, but its water conservation record is poor, outdated,with insufficient water purification infrastructure, as well as persistent fears about the degradation and quality of water availability (Viljoen & van der Walt 2018).According to ACF (2016) the governance systems principally regulate when, how and who gets water, and which amongst citizens has the rights to water, water related services and benefits (ACF 2016).

The FAO (2018) emphasized that the ambiguity about the quality and amount of obtainable water yearly in relationto flows and stocks has been the key challenge of water governance in most developing countries. This has resulted to water governance being commonlyknown as the main weakness in water resource management. Water accounting therefore assist governments to understand and note the amount of available water and its location to ensure sustainable water availability (FAO 2018).Governance play an important role in providing tools to reach the final objectives that would assure residents' rights to water access and sanitation. It is very important to ensure that pricing of water is appropriate, while making sure that socially disadvantaged and vulnerable citizens are not deprived of access to water resources.

Water conservation

Water must be conserved and protected because it is important and plays a vital role in all sectors of the economy. However, a range of measures are initiated which includes water conservation and demand management; the use ground water; re-use of water at the coast; adopting cost-effective and suitable sites for dams and transfer schemes; desalination of sea water and de-acidification of mine water; and rehabilitation catchment, removal of invasive alien plants and rainwater harvesting (DWA, 2013b). Water conservation is an upgraded water administration exercises that lessen or improve the valuable utilization of water, these include measures like changes in behavior, improved technologies and designs implemented to minimize water waste, losses and / usages (Kumar & Singh 2016).Water scarcities possess an obvious hazard to agricultural sustainability and environmental stability. Thus, water conservation practices are the basis of economically viable and environmentally comprehensive practices of agrobusiness schemes (Bashir, Javed, Bibi & Ahmad 2017). Empirical evidence has shown that for the past decade there has been a significant increase in agricultural production costs associated with declined in yields. This has been caused by the erosion of the most productive part of the soil profile referred to as the topsoil. Erosion has resulted to rills and gullies which makes paddocks tilling to be impossible.The pollution of water with residues and chemicals has been amongst the major problems in the agricultural sector (Bashir *et al*. 2017). The need to conserve water both for domestic and agricultural use becomes imperative in the light of numerous changes in climate.Water conservation strategies are demand, management and supply oriented therefore the strategies differ according to the water use need such as irrigation, domestic or industrial use (Kumar & Singh 2016). Kumar & Singh (2016) accentuated the importance of water conservation in the agricultural subdivision as water is crucial for crops and plants growth (Kumar & Singh 2016). The reduction in water table and increase in salinity caused by over utilization of pesticides and fertilizers has worsen the situation.

Several water harvesting and revitalizing methods have been applied nationally to resolve conservation issues.Local citizens use simple techniques that are suitable for their area to lessen water demands in water scarce and low rainfall arears (Kumar & Singh 2016).Aquatic conservation actions in industries must comprise of appraisal of substitute production procedures and technologies from the viewpoint of water consumption, guaranteeing comprehensive plant conservation practices and organization, reducing water leaks and spills; and increasingof water treatment to attain maximum reprocessing (Kumar & Singh 2016). To ensure water conservation farmers need to change their habits and attitude and try by all possible means to reuse water, consciously noting that every drop of water is important.

Implication of water resource management for agricultural extension

The framework for water conservation and protection in South Africa is provided by the National Water Resource Strategy (NWRS). The total water losses resulting from physical leaks, inaccurate metering, and theft stands at 36.8% with an estimated 1,58 billion m^3 of water unaccounted for annually. Agriculture, which accounts for 60% of all waterconsumed, experiences an estimated water lossof30-40%.The NWRS has warned that it is becoming gradually difficult and costly in meeting the increasing demand for water in South Africa(Stevens and van Koppen2015). Therefore, all sectors including extension must be saddled with the task of piloting an enduring initiative for water resource management. The synergies between sectors involved in water resource management must be reinforced for effective management.

Extension should assist in upgrading farmers capacities and awarenesstominimizing the negative environmental impactsof irrigation, reducing the productioncost, and contributing to the sustainability of irrigated farming in South Africa. However, despite the technical, social, and econoic limitations which constitute a handicap in achieving the objectives of the advisory services, water resource management must be promoted with flexibility and focus on practical solution. Water resourcesis a primary ecosystem component which is very importantfor livelihood. In this time and age, the implication of water conservation overrides other interest in water management, and the

achievement of efficiency in a litre of water used in homes or agriculture is considered critical in enduring food security and poverty alleviation. Water conservation initiatives is associated with social context and personal attitude and perspectives. However, water resources must be managed both in the future and in the present since changes in water development will have impact on food production. Agricultural advisory services shoulddo more to supportwater management and governance bypersuading farmers to adopt strategies such as selecting appropriate irrigation practices, conscientizing farmers towards appropriate irrigation systems, introducing theuse ofcrop varietiesresistant to drought, and creating irrigation cooperatives(Veisi & Bijani 2018).

Studies has shown that poor presentations of extension and advisory services is mainly attributed to inadequate financial assistance,and this has impacted negatively on agricultural productivity in Africa (Davis & Terblanche 2016).The task of extension and advisory service practitioners are enormous and must continue workingtogether with farmers in replacing farming systems which are not ecosystem friendly. Extension advisers be acquainted with issues on irrigation and water management. The reliance of subsistence farmers on extension personnel is not solely confirmed to provision of information but also as mediators amongst farmers and various stakeholders (Olayemi&Dorasamy 2016). However, the influence of agricultural extension has not been fully recognizedassizeable percentage of the population in South Africa live in rural communities.

CONCLUSION

The paper comprehensively examined agricultural water demand and supply, governance, conservation, and implication for agricultural extension service and made a submission for the application of efficient water management strategies which remains a key componentfor increase water productivity. In addition, the assessment of crop management strategies, the improvement of irrigation systems and irrigation schemes can lead to a more efficient and sustainable agricultural water management.Appropriate policy measures in agriculture and the implementation of efficient farmer advisory schemes are critical for future economic growth in south Africa.Government and extension should do more to support and conscientize farmers towards appropriate irrigation systems aimed at minimizing water losses. There is a need for sustained efforts to manage existing water resource infrastructures by all stakeholders for the benefit of the farming communities.

RECOMMENDATIONS

The attainment of efficiency in any litre of water used in homes or agriculture is critical in ensuringwater conservation, food security and poverty alleviation.Consumption of water can be effectively reduced if every South African could consider water conservation as the responsibility of everyone while embracingmodification ofhuman habits in water utilization practices. The significant role played by extension advisors in agricultural development must not be ignored as it will enhance farmers welfare and food security. Through extension advisory services,farmers could be responsive to water resource management and conservation.

LIMITATIONS OF THE STUDY

The study is constrained by inadequate and current grey literature andrepositories. However, the topic has the potential to transcends boundaries relevant to water governance, management, and revitalization. The topic and discussionsarepeculiarto South Africa and may not be generalised.

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REFRENCES

[1] Abegunde VO, Sibanda, M, Ajuruchukwu O2019. Determinants of the Adoption of Climate- Smart Agricultural Practises by Small-Scale Farming Households in King Cetshwayo District Municipality, South Africa.

[2] Agholor AI, Nkosi M2020. Sustainable Water Conservation Practices and

Challenges among Smallholder Farmers in Enyibe Ermelo Mpumalanga Province. Nelspruit. *Journal ofAgricultural Extension*, 24 (2):112-123.

[3] Agholor AI2013. The Revitalization of Water Resources for Sustainable Agricultural Development in South Africa: A review. *Journal of Agricultural Science*, 5(5):76-82.

[4] Aither 2018. A Guide to Managing Water for the Environment. A framing paper for the High- Level Panel on Water. Australian Water Patnership, Canberra.

[5] Ashton PJ 2002. Avoiding Conflicts Over Africa's Water Resources. Division of Water, *Environment & Forestry Technology*,31(3):236-242.

[6] Bashir S,Javed A. Bibi I. & Ahmad N. 2017 Soil and Water Conservation. Institute of Soil and Environmental Sciences. Faisalabad.

[7] Borisova T2012. Agriculture and Water Availability Issues: An Overview. Food and Resource Economics Department, University of Florida.

[8] Bwapwa JK 2018. Review on Main Issues Causing Deterioration of Water Quality and Water Scarcity: Case Study of South Africa. *Environmental Management and Sustainable Development*, 7 (3).

[9] Davis & Terblanche. 2016. Challenges Facing the Agricultural Extension Landscape In South Africa, Quo Vadis? Global Forum for Rural Advisory Services. *International Food Policy Research Institute,* 44 (2): 231- 247.

[10] Department of Water Affairs and Forestry (DWAF). 2010. National Groundwater Strategy. Pretoria: Department of Water Affairs and Forestry) Department of Water Affairs (DWA). 2013a. National Water Resource Strategy, Second Edition.

[11] Pretoria, Department of Water Affairs

[12] Department of Water Affairs (DWA). 2013b. Dam safety office: Annual report 2011-2012.

[13] Pretoria: Department of Water Affairs Donnenfeld Z, Crookes C. & Hedden S. 2018. A delicate balance Water scarcity in South Africa. South African Report. Institute for security studies.

[14] Elum ZA, Modise DM, Marr A2016.Climate Risk Management. Farmer's perception of climate change and responsive strategies in three selected provinces of South Africa.*Climate Risk Management, 17: 246-257.*

[15] Elke Herrfahrdt-Pähle E 2010. South African water governance between administrative and hydrological boundaries, *Climate and Development,2 (1)111–127*

[16] Ensor J2011. Uncertain Futures: Adapting Development to a Changing Climate. Practical Action Publishing, Rugby, UK.

[17] Food and Agriculture Organization2018. Water Accounting for Water Governance and Sustainable Development. Food and agriculture organization of the United Nations. World Water Council. Rome.

[18] Food and Agriculture Organization, 2020. Integrated Production and Pest Management Programme in Africa. Food and Agriculture Organization of the United Nations.

[19] Food and Agriculture Organization 2012. Coping with water Scarcity. An action framework for food and agriculture. Rome.

[20] Frison EM, Jeremy C, Hodgkin T2011. Agricultural Biodiversity Is Essential for a Sustainable Improvement in Food and Nutrition Security. Sustainability. Rome.

[21] Garcia de Jalon S. Iglesias A. & Diaz P. 2014. Building resilience to water scarcity in southern Spain: A case study of rice farming in Donana protected wetlands. *Reg Environ. Change*, 14(1):122-1242.

[22] Greentumble2016. Water Saving Methods in Agriculture: Effective ways to reduce water consumption on farms. Sustainable farming.

[23] GWP2014. Strategy Towards 2020. A water secure world. Global Water partnership. Liberia.

[24] Hassan R2011.Transforming Water Management in South Africa: Designing and Implementing a New Policy Framework, Springer, London. Vol.2

[25] Hristov J2014. The role and use of water in agriculture in the Western Balkans: The case of Macedonia. Acta Universitatis agriculture Suecia.

[26] Iglesias A, Garrote L2015. Adaptation strategies for agricultural water management under climate change in Europe. *Agricultural water management*.155(1):113-124.

[27] Jankielsonhn R 2018. Defining Hydro-politics: The Politics of Water in South Africa. *Journal of contemporary history*, 37 (1):123-141

[28] Khan TH2014: Water scarcity and its impact on agriculture – Case study of Layyah, Pakistan. Swedish University of Agriculture

[29] Kranz N, Interwies E, Vorwerk A,Raggamby AV 2005. Governance, Institutions and Participation in the Orange-Senqu Basin. Report to Ne Water project, Berlin.Division of Rural Development

[30] Lewis P, Monem MA,Impiglia A 2018. Impacts of Climate Change on farming systems and livelihoods in the near east and North Africa. With a special focus on small-scale family.

[31] Mabhaudhi T, MpandeliS, Nhamo L, Senzanje A,ChimonyoGP, Modi AT2019. Options for Improving Agricultural Water Productivity Under Increasing Water Scarcity in South Africa.

[32] Mabhaughi T,Mpandeli S, Nhamo L, Senzanje A, Chimoyo VGP, Modi AT2019. Options for Improving Agricultural Water Productivity under Increasing Water Scarcity in South Africa. Indonesia.

[33] Maisonet- Guzman O 2011. Food Security and Population Growth in the 21st Century.

[34] MaponyaP,Mpandeli S 2013. The role of extension services in climate change adaptation in Limpopo province, South Africa. Journal of Agricultural Extension and Rural Development.5(7):137-142.

[35] Mare FA, Grove B, Willemse 2015. Estimatingthe Maximum Value of Crop Hail Insurance Under Stochastic Yield and Price Risk.

[36] Maya WE2018. Climate Smart Agriculture for Smallholder Farmers in Southern Africa.

[37] Mnisi N2020. Water Scarcity in South Africa: A result of Physical or Economic Factors? Hellen Suzman Foundation.

[38] Mutiro J, Lautze J2015. Irrigation in Southern Africa: success or failure? In: Irrigation and Drainage.Wiley Online Library. DOI: 10.1002/ird.1892

[39] Ochieng GM, SeanegoES, Nkwonta OI 2010. Impacts of mining water resources in South Africa: A review. *Scientific Research and Essays*, 5(22): 3351-3357.

[40] OECD 2010.Sustainable Management of Water Resources in Agriculture. Organization for economic co-operation and development.

[41] Olayemi B,Dorasamy N2016. Creating economic viability in rural South Africa through water resource management in subsistence farming. *Environmental Economics*. 7 (4): 12-33

[42] Ortiz R 2012. Climate Change and Agricultural Production. Inter-American Development Bank. Environmental Safeguards Unit.

[43] PatleG, Kumar M, Khanna M 2019. Climate-Smart water technologies for sustainable agriculture: A review. Indian *Journal* of Agricultural Sciences, 87 (1):12–22.

[44] Pengelly C, Seyler N, Fordyce P, Janse van Vuuren, van der Walt M, van Zyl H, Kinghorn J2017.

[45] Managing Water as a Constraint to Development with Decision-Support Tools That Promote Integrated Planning: The Case of the Berg Water Management Area. Water Research Commission.

[46] Powertech2012. Creamer Media 's Report. Water 2012. A review of South Africa 's water sector. Johannesburg.

[47] Sawicka B2019. Resilient Agricultural Practices. Department of plant production technology and commodities science. Lublin.

[48] Seetal AR, QuibellG 2005. Water rights reform in South Africa. Water Rights Reform: Lessons for Institutional Design, B. R. Bruns, C. Ringler and R. Meinzen-Dick (eds). International Food Policy Research Institute, Washington, DC.

[49] Stevens J, van Koppen, Barbara2015. Trends and Outlook: Agricultural Water Management in Southern Africa. Country Report South Africa.

[50] Tortajada C 2010. Water Governance: Some Critical Issues. *Water Resources Development* ,26 (2):297- 307**.**

[51] Veisi K, Bijani M 2018. The role of Agricultural Extension and Education towards Water Resources Management and Governance. The 7th Iranian Congress on Sustainable Agricultural Extension & Education, Natural Resources and Environment. Iran.

[52] ViljoenG, van der Walt K2018. South Africa's water crisis - An interdisciplinary approach. *TydskrifvirGeesteswetenskappe*. 58. 483-500.

[53] Walker WR, Zaccaria D2014. Agricultural Water Management Challenges in the Western US.DOI:10.13140/2.1.1716.5449.