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The role of private agronomists towards the sustainability of commercial crop farmers in the eastern highveld of Mpumalanga, South Africa

Bruwer, P.W.[1] and Khwidzhili, R.H.[2]

Corresponding author: P.W. Bruwer E-mail: pieter@bruwer.net

ABSTRACT

The face of extension and advisory services for agriculture in South Africa has changed significantly in recent years. The focus of government extension services has shifted to emerging farmers, impacting the quality of extension available to commercial farmers. This paper explores the effect of this shift on the sustainability of commercial crop farming in the Eastern Highveld. Three areas of advice and the impact on sustainability were researched, namely soil management, plant nutrition, and crop protection. Crop farmers regard all three as crucial for sustainability and prefer advisors to be knowledgeable in the following order of preference: plant nutrition, soil management, and crop protection. Most farmers are aware of their advisors' qualifications and accreditations and discount advice by non-accredited and inexperienced advisors. Sustainable advice followed by responsible application is more effective in crop protection than soil management and plant nutrition. Over the past decade, the contribution of qualified advisors through improved decision-making increased yields by upwards of 40%. To maintain a high level of scientific and ethical advice, supply companies should employ qualified agronomists and promote the importance of qualified advice among stakeholders. Advisors should promote an ethical and professional relationship and regularly offer mentorship to qualified but inexperienced advisors.

Keywords: Agronomist, Advisor, Qualified advice, Sustainable crop production

[1] PhD Candidate, University of the Free State, Sustainable Food Systems and Development, PO Box 339, Bloemfontein, 9300. Tel. 051 401 3765. Senior Agronomist, Langfontein Seeds. PO Box 272, Wakkerstroom, 2480, Mpumalanga. Tel. 017 730 0411; E-mail: pieter@bruwer.net

[2] Senior Lecturer in Agricultural Extension and Rural Resource Management, University of Mpumalanga, P/Bag X 11283, Nelspruit, 1200. Tel. 013 002 0144; E-mail: humphrey.khwidzhili@ump.ac.za

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1. INTRODUCTION

Agriculture as a business and a means of livelihood in South Africa has undergone major changes in the last 50 years. The major drivers behind these changes can be narrowed down to population growth, increased food production, political stability or instability, climate change, and technology. South Africa has a unique situation where the commercial agricultural sector (CAS) was, for many years, predominantly made up of white farmers. Furthermore, in terms of land ownership, more than 80% of agricultural land is owned by white commercial farmers while the white population makes up a mere 13% of the country's population (Kalaba, 2015). The post-1994 government and its Department of Agriculture, Forestry, and Fisheries (DAFF) focused mainly on these farmers but accepted that its policies and focus had to change. This was confirmed by the DAFF spokesman addressing parliament through the Parliamentary Briefing Committee in 1999 when he admitted that part of the transformation that the Agricultural Research Council (ARC) was undergoing involved shifting from the commercial sector to aid and uplift small-scale and subsistence farmers (ARC Parliamentary Briefing Committee, 1999). This shift was also justified by the steadily declining number of commercial farmers in South Africa. In 1980 there were 128 000 commercial farmers in South Africa, but this figure decreased to 58 000 in 1997 (Gosling & Moolla, 2011). Currently, the number is 40 122 (Stats SA, 2020). The more prominent research institutions such as the Agricultural Research Council (ARC) and universities that conducted research towards sustainable agriculture soon followed suit and changed their focus accordingly.

Following South Africa's national elections in 1994, the Department of Agriculture declared that the number of extension officers would be increased from 2 500 to 5 000 to accommodate the process of land reform and in so doing assist emerging farmers (Maka & Aliber, 2019). The factors and events outlined above undoubtedly influenced commercial farmers who relied heavily on the expertise of the relevant governmental institutions, universities, and research facilities as well as on the guidance provided by extension officers and their experts. On a continent where research data often does not reach end-users (Abutu, 2016), advisory services and commercial farmers are now facing a new challenge. This sudden shift in the Department's focus from commercial farmers to emerging farmers created a dissemination vacuum that impacted negatively crop production and the entire agricultural value chain as commercial farmers had to turn to the private (non-

governmental) sector for technical and other assistance (Koch & Terblanché, 2013). Without disregard for the enormous contribution from the other drivers of change – such as land reform, politics, and climate change, to name a few – this study will focus on the current situation regarding the availability and importance of agronomic services and the importance of the supply companies that employ agronomists in the commercial agricultural sector.

The international farm advisory sector has likewise changed significantly over the years and one of the important drivers of change has been reduced government investment in agricultural extension (Sewell, Hartnett, Gray, Blair, Kemp, Kenyon, Morris & Wood, 2017; Nettle, Crawford & Brightling, 2018). Historically, agricultural experts focused on improving farm productivity. However, they must now also consider other issues such as environmental sustainability, animal welfare, and health and safety regulations (Eastwood, Ayre, Nettle & Dela Rue, 2019). This trend is confirmed by the United Nations Food and Agriculture Organization (FAO, 2020). Commercial farmers are becoming increasingly reliant on private advisors, suppliers of agricultural products that offer advisory services, and, unfortunately, many unqualified advisors (Miles, 2018). In light of this development, some pressing questions, however, do come to mind, such as how the farmer communicates with the current researcher, the way the supplier ensures that the farmer receives this information, and ways to ensure the correct application of the results and research information. The qualified agronomist, whether in a private capacity or employed by a supply company, is the most likely and effective link between research and the farmer. This is confirmed in the functions of an agronomist as defined by Ingram and Morris (1987) and AgCareers (2020). For this study, conducted in the commercial sector, the term advisor applies to a person in a crop production advisory capacity, even if not formally qualified or experienced to act as such. For example, a representative of a fertilizer company, without a scientific degree, similar qualification, or accreditation with a regulatory body as explained below, advises a farmer on the results of soil analysis and subsequent fertilizer requirements. It may very well be the case that such an individual does not have any experience in this particular field either.

An agronomist is a person formally qualified to advise crop producers. The South African Council for Natural Scientific Professionals (SACNASP, 2019) considers a four-year Bachelor of

Agricultural Science (B.Sc.Agric.) degree as the minimum qualification for someone to qualify as and be deemed an agronomist. Two types of agronomists, namely private agronomists, and state-employed agronomists have been relied upon as a reference for this paper. This study mainly focused on private agronomists who can be further subdivided into two categories: private agronomists who are not employed by or have no ties with any agricultural supply company and are hired through a retainer of sorts, and retail agronomists. The latter is usually employed by a supply company such as a fertilizer or chemical company whose services are provided through the purchasing of products (Darbas & Lawrence, 2011). The term "accredited" indicates that an agronomist or advisor has successfully obtained a certificate of competence or completion from a regulatory authority in a specific field of expertise related to crop farming. Examples include the Association of Veterinary and Crop Associations of South Africa (AVCASA) and the Fertilizer Association of South Africa (FERTASA). The above-mentioned explanation serves to illustrate the difference between qualified advice and unqualified advice.

2. PURPOSE AND OBJECTIVES OF THE STUDY

The purpose of this study was to highlight the role of private agronomists in the sustainability of commercial farmers, regardless of the farmers' level of technology, the availability of funds, or the scale of the operation. The study also identifies farmers' reliance on expert services offered by an agronomist and determines whether farmers prefer and are prepared to hire independent private agronomists at an agreed fee. It also highlights the fields of expertise that are essential to the farmer. There is concern over the communication of scientific research results between researcher and farmer and the study also determined whether the crop farmer believes that the agronomist plays a role in this process. Communication of scientific results is an important factor in sustainable crop farming. There is a perception amongst crop producers on the Eastern Highveld that not all agricultural advisors in the commercial farming sector are qualified to make scientifically based recommendations in the best interests of the crop producer and the environment. This perception probably originated from the conflicting advice and recommendations that farmers are increasingly being exposed to. Blanca, Noe, Burma, Burnett, Compagnone and Marraccinie (2010) concluded that some advisors, while part of the supplier companies promote higher consumption of pesticides because of their trade-related interests. Lastly, this paper also evaluates whether commercial

farmers possess certain skills and knowledge in terms of crop production, their expectations of the agronomist and if they believe current and future technology could replace certain functions generally performed by agronomists. During this study, the three crucial areas in crop production where expert advice is of the utmost importance were identified as soil management, plant nutrition, and crop protection.

3. RESEARCH DESIGN AND INSTRUMENT

For this study, a quantitative approach was applied. The questionnaires were either handed out in person or e-mailed to a selection of thirty-one (31) irrigation and/or dryland crop farmers on the Eastern Highveld of Mpumalanga. The participants ranged from the age of 21 to 65 and where the only requirement was to be a commercial crop farmer. It was important to find respondents from a wide and representative scale of operation starting with the smaller-scale farmer (less than 100 ha) towards the medium-scale farmer (meaning an area of no less than 100 ha but not exceeding an area of 1 500 ha) and the larger-scale farmer (more than 1 500 ha) as the area is known for a combination of cash crops, and crops for feeds and livestock. A farmer who grows more than 500 ha of crops is therefore considered a notable crop grower. In compliance with the applicable Covid-19 regulations, all participants completed the questionnaire in their own time and submitted it online, via e-mail, or, in some instances, questionnaires were collected from specific participants between September and October 2020. Only the answers to the questionnaire were captured and analysed using the data analysis software SPSS and Microsoft Excel in creating descriptive statistics. Descriptive statistics are broken down into measures of central tendency and measures of variability (Kenton, 2019; Sharma, 2019). Data is presented in a combination of graphs (figures), tables (tabular), calculations to summarize data (figures or graphs), and subsequent interpretation through the grouping of data in the above-mentioned tables in terms of the objectives, to determine trends and/or deviations from the answers in the questionnaire.

4. RESULTS AND DISCUSSION

This section presents the results obtained and analysed from data collected in the study area. The contribution of soil management, plant nutrition, and crop protection towards sustainable crop farming will be presented in the form of tables and graphs accompanied by a discussion.

4.1 Soil management and plant nutrition

It is encouraging to find that 100% of respondents regarded soil management as a crucial component of crop farming and reported that they require expert advice regarding soil issues. All respondents use soil sampling as a tool to monitor soil health. Also inspiring is the fact that all participants acknowledged the importance of physical inspections of soil profile pits as part of sustainable soil management. Some researchers emphasised that a soil sample is an important tool in soil management and plant nutrition; this observation is supported by Ingram and Morris (2007) and Carberry, Hochman, Mccown, Dalgliesh, Foale, Poulton, Hargreaves, Cawthray, Hillcoat and Robertson (2002). Regarding the matter of expert advice, most of the respondents confirmed that they rely on an agronomist or soil scientist to interpret the laboratory results followed by the fertilizer recommendation. A substantial majority of the respondents (81%) were certain that their advisor was accredited and qualified for this task. In terms of the contribution towards sustainable crop production, the majority (90%) of respondents reported a 50% or more improvement due to proper soil management practices and most of the farmers (74%) believed the contribution made by their plant nutrition advisor in terms of fertilizer and fertilizing practices even surpassed a percentage of 50%. Crop farmers are aware of the importance of expert advice as indicated by the fact that 97% of respondents prefer to buy agricultural inputs from supply companies that employ agronomists from whom they can seek advice and support. Also, more than half (58%) of the participants regard the issue of the product price as of lesser importance than having recourse to qualified advice. In other words, they are willing to pay more for a product knowing that the agronomist will assist them with specialized advice.

4.2 Crop protection

Advisory services in the agrichemical industry are regulated to a certain extent. Most of the respondents were content with their crop protection advisor; even so, the fact that 21% of the respondents were not aware of any required accreditation, is concerning. The relatively high percentage (84%) of respondents that reported a greater than 50% improvement in sustainable crop production as a result of the input of a qualified and accredited advisor may be an indication of the

importance thereof. Once again, most of the respondents (87%) preferred products from suppliers that offer qualified advice together with the product.

4.3 General crop production sustainability

4.3.1 Private agronomists and supply company agronomists

The issue of private agronomists is a relatively new concept in South Africa and most respondents still prefer an agronomist employed by the same company supplying the products. Slightly less than half of the crop farmers (48%) were prepared to pay for independent qualified advice. Table one shows that only 45% of respondents would prefer to pay less for the product and employ the services of a private agronomist at a fee. This is in stark contrast to commercial farming in other countries where private agronomists are widely used. Birkhaeuser, Evenson, and Feder (1991) state that private agronomists are generally better organized and more flexible in their respective fields of expertise. It is unclear whether this is the case in South Africa and needs to be investigated.

Table 1: The choice to buy products at a reduced price or pay more where advice is included

Advice included, or not	Frequency	Percentage
Pay less for the product, but pay for an independent expert opinion	14	45
Pay more for the product which includes expert advice	17	55

4.3.2 Advice without input from an agronomist

Some valid concerns regarding unqualified persons – such as some sales representatives or marketing agents who act as advisors of crop production – have been raised. Figure one shows the overwhelming response from respondents that 93% would not be content with advice and guidance disseminated without the input of a qualified agronomist. This implies that most farmers understand the importance of an agronomist or qualified agricultural advisor as essential for sustainable crop production.

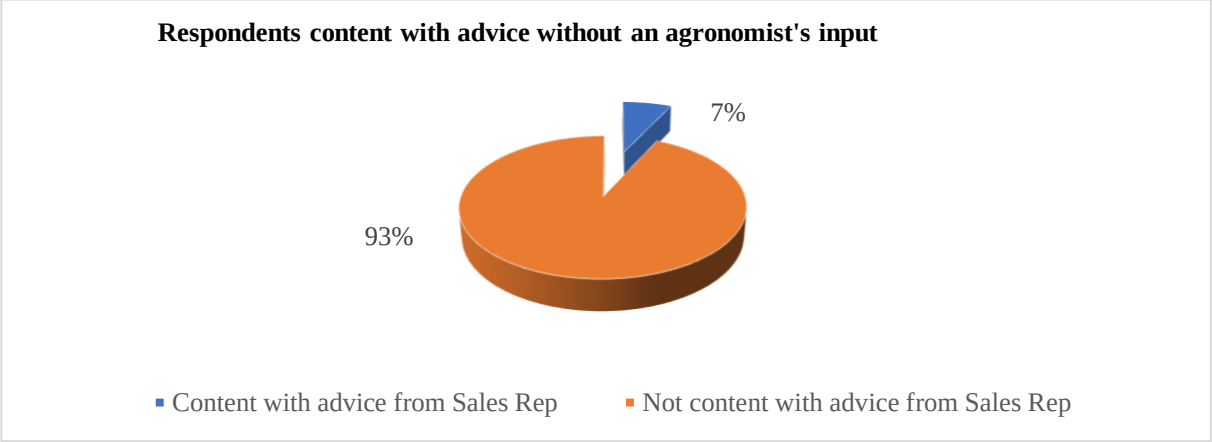

Figure 1: Respondents' preference towards advice from an agronomist

4.3.3 Advisor's field of expertise

From Figures two, three, and four it is clear that regarding the three disciplines researched, respondents would prefer advisors to be most knowledgeable in soil management (52%), followed by plant nutrition (49%), and lastly crop protection (39%). This result should not be interpreted as an indication of an order of importance or the extent of its contribution to sustainable crop farming, but rather as an indication of where crop farmers require more or are in greater need of expert advice.

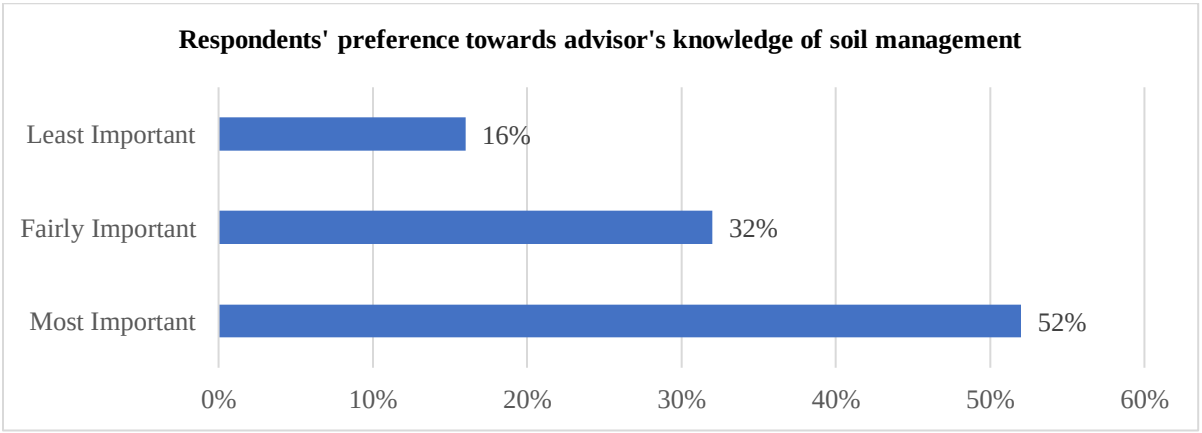

Figure 2: Importance of advisor's knowledge of soil management in sustainable crop production

When compared to soil science and plant nutrition, the agrichemical industry is an exact and visible science, at least from the crop producer's perspective. Results from underdosing, overdosing and effective or ineffective recommendations are sometimes immediately visible and easily measurable. The short-term risk to the farmer, advisor, and supply company is far greater than in the case of soil management and plant nutrition. This research result may be attributed to the fact that most advisors in the agrichemical field are qualified and/or accredited and therefore already provide a standard of advice with which the farmer feels safe and comfortable.

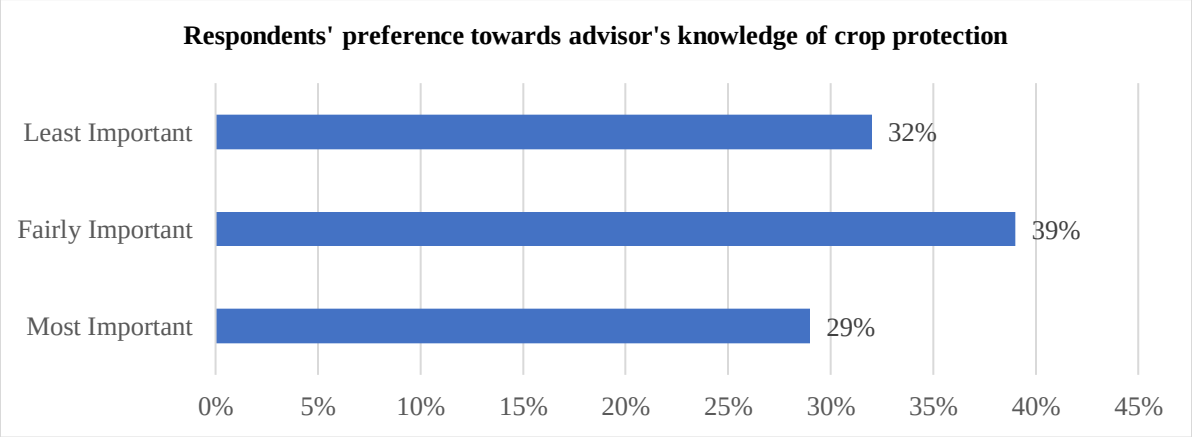

Figure 3: Importance of advisor's knowledge of crop protection in sustainable crop production

In contrast to the scenario with agrichemicals, crop farmers have a greater need for scientific assistance with soil management. The concept of soil science, the nature of the chemical, and the physical properties of this valuable resource make the management thereof a long-term strategy. It furthermore offers slow results and some effects of soil management are only noticeable or measurable after many years. This, together with plant nutrition, is a complicated science where producers must have qualified assistance. Sustainable soil management is a crucial part of sustainable agriculture and the study confirmed that crop producers are acutely aware of its importance. Crop producers acknowledged the importance of specialized advice in this field and most farmers are confident that their advisor is knowledgeable. It is important to note that the standard of competence of the modern agronomist has shown a considerable increase over the previous decade (Ingram & Morris, 2007). Adaptation towards new technology, research results,

and farming practices, to mention a few, is an ongoing process and the responsibility of every advisor. The evolution of the agronomist and the design of agricultural systems are well described in a study undertaken by Salembier, Segrestin, Berthet, Weil, and Meynard (2018).

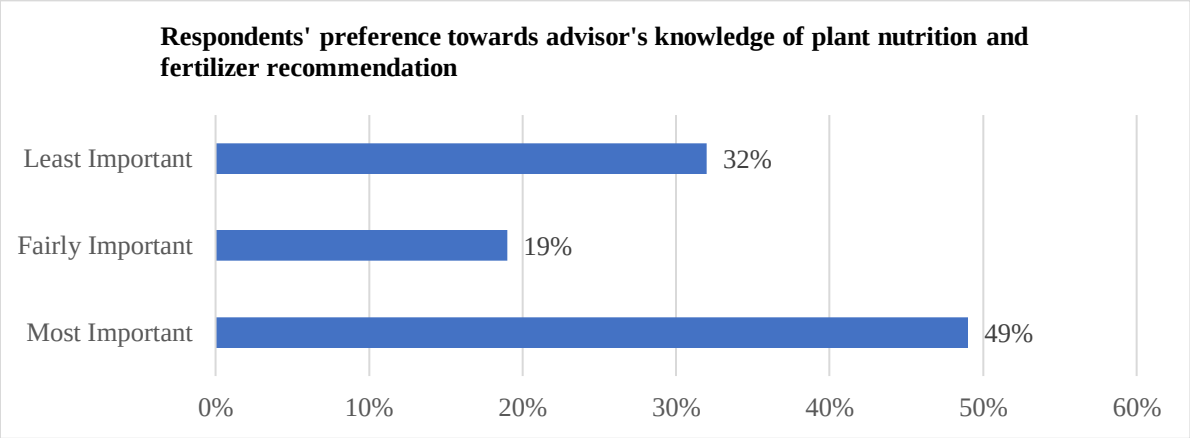

Figure 4: Importance of advisor's knowledge of plant nutrition and fertilizer recommendation in sustainable crop production

4.3.4 Technology, the farmer, and the agronomist

Agriculture, like most other industries in the world, is overwhelmed by new technology. Commercial crop farming has become a hi-tech industry. It is not surprising that most of the crop farmers (77%) who participated in the study have obtained a tertiary qualification such as a university degree, college diploma, or university of technology degree. The remaining 23% have obtained at least a Grade 12 high school qualification. Figure five shows that most crop farmers utilize more than half of the available technology, but more importantly, it is significant that 48% of commercial farmers believe that they use 70% or more of the available technology to grow crops. Some smaller-scale farmers use technology such as satellite guidance systems, GPS mapping of fields, and satellite-guided differential application of lime, fertilizer, and chemicals. Even though the average crop farmer on the Eastern Highveld is technologically advanced, most farmers (84%) feel that technology can replace only a limited number of the functions carried out by the agronomist or even not at all. Together with Porter (2015), most farmers believe that the role of the agronomist will become more prominent with increased levels of technology.

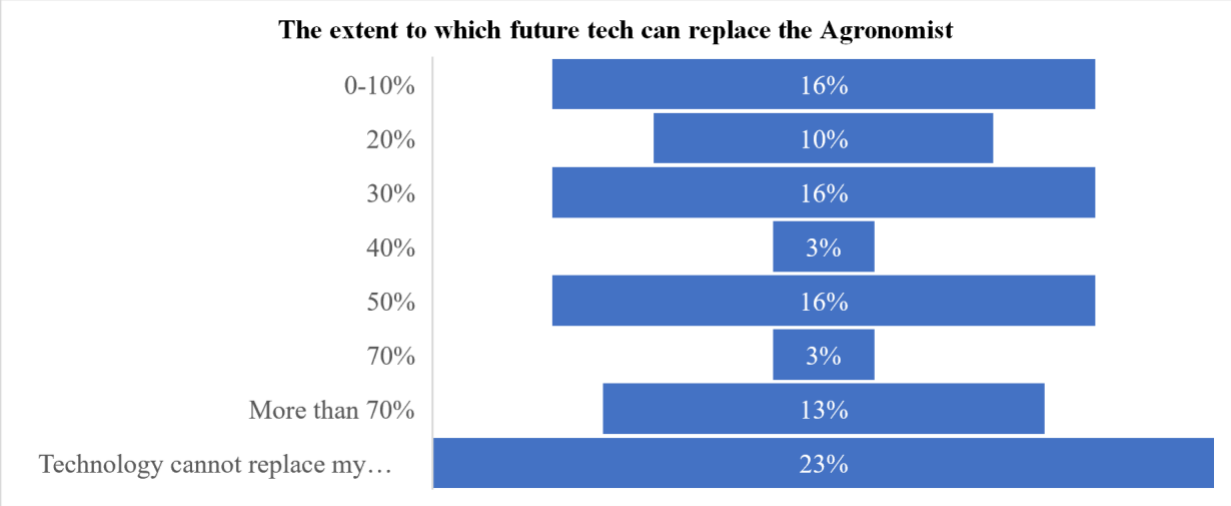

Figure 5: The extent to which technology may replace certain functions of the agronomist

4.3.5 Keeping the farmer informed

A further important function of the agronomist is to keep the farmer informed of the latest research results and trends in a specific farming sector. Most respondents replied that they were confident that their advisor would keep them informed – usually an important function of a qualified and ethical advisor. A troubling 19% of farmers were uncertain about being regularly updated with research results and which could indicate that the level of expertise and knowledge of their advisor is inadequate. This is a cause for concern and communication between the researcher, advisor and farmer needs to be researched more fully.

4.3.6 Importance of information sessions

Most information sessions and farmers' days are organized through the private sector. Supply companies of seed, fertilizer, chemicals, and equipment are largely responsible for information sessions. More than 61% of respondents regard information sessions as very important, 36% as fairly important, and 3% as not important. Combined, a total is 97% of farmers thus find information sessions important as a means of being updated on research data and the latest trends.

5. CONCLUSION AND RECOMMENDATIONS

Since the democratic elections in 1994, a great amount of research and recommendations have been conducted and made in the South African context regarding agricultural advisors and

extension services (Khwidzhili & Worth, 2019; Khwidzhili & Worth, 2016; Maka & Aliber, 2019), but more is needed regarding the advisory services as it pertains to the private sector. This study shows that qualified agronomists and advisors in the fields of plant nutrition, crop production, and soil management contribute more towards sustainable crop production than unqualified advisors. Crop farmers on the Eastern Highveld – either for cash crops, feed, or both – regard soil management, plant nutrition, and crop protection as vitally important for sustainable crop production. These different groups of commercial crop farmers have the same requirements in terms of qualified advice. The data derived from the questionnaires confirmed that farmers are not content with advice from unqualified individuals such as sales representatives or marketing agents and they prefer to obtain commodities from supply companies that employ qualified agronomists.

These farmers regard qualified advice as more important than the price of a product. Interestingly, technology, although an important feature and effective tool, is not essential to be a sustainable crop farmer and that could be the reason why smaller sustainable farmers are reluctant to invest in expensive technology and thus rely more on agronomists for advice. Large-scale farmers, on the other hand, rely on agronomists for assistance in the process of managing the crop throughout the growing season to reduce the managerial load on themselves. Albeit for different reasons, the function of the agronomist is equally important to smaller and larger crop farmers alike. It appears that farmers on the Eastern Highveld are not yet ready to use private agronomists, but rather prefer the services of experts employed by supply companies. Commercial crop farmers are increasingly becoming aware of the advantages of utilizing qualified agricultural advice.

This study recommends that agronomists, advisors, and sales representatives working in the agricultural environment must seek accreditation from the relevant regulatory authorities. These authorities, in turn, must consider regulating advisors working in the fields of plant nutrition, fertilizers, lime, and soil management and encourage participation in the training and writing of their accreditation exams. It must be compulsory, as is currently the case in the agrichemical industry. Agronomists and advisors must inform farmers of their qualifications so that crop growers can have complete confidence in the guidance and advice disseminated. A culture of "being aware of your advisor's qualifications and accreditations (or lack thereof)" should be

developed amongst crop farmers. Supply companies must employ more agronomists who, in turn, must make sure that they visit the farmers and their fields as frequently as possible to develop a relationship of mutual trust. Farmers have indicated that they are willing to purchase the supplies they require from such companies.

Furthermore, regulatory authorities, associations, agricultural supply companies, and private agronomists have a responsibility towards the sustainable utilization of natural resources that can only be achieved by ensuring that all advisors and role players in the agricultural advisory sector have the necessary training and accreditation to comprehend the importance of scientific and sustainable advice. Agronomists, advisors, and supply companies must organize regular information sessions and farmers' days to interact with crop producers and ensure that producers are updated with the latest information regarding research and technology and, most of all, the importance of sustainability.

Crop farmers have a similar responsibility towards the environment and sustainable agriculture by adhering to scientific guidance from accredited and qualified advisors. The interpretation and communication of scientific research data to the end user is the responsibility of all stakeholders in the dissemination chain of agricultural information. Sustainable agriculture, in its entirety, is based on responsible research, the dissemination of responsible research results, and, ultimately, the responsible application thereof.

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REFERENCES

ABUTU, A., 2016. Experts call for open agricultural data platform. Viewed 15 May 2020. https://www.scidev.net/sub-saharan-africa/agriculture/news/agricultural-research-and-data-accessible.html?

AGCAREERS. 2020. Agronomist: what responsibilities will I have? Viewed 14 May 2020. https://www.agcareers.com/career-profiles/agronomist.cfm.

AGRICULTURAL RESEARCH COUNCIL (ARC). 1999. Parliamentiary briefing agriculture, Land Reform and Rural Development. Parliamentary briefing committee. Viewed 22 March 2020. https://pmg.org.za/committee-meeting/3128/.

BIRKHAEUSER, D., EVENSON, R. & FEDER, G., 1991. The economic impact of agricultural extension: a review. Economic development and cultural change, University of Chicago Press, *vol. 39(3), pages 607 – 650,* April.

BLANCA, J., NOE, E., BURMA, J., BURNETT, M., COMPAGNONE, C. & MARRACCINIE, E. 2010. The role and attitudes of agricultural advisors in implementing sustainable pest management in European agriculture – a cross national case study in NL, FR; UK and DK. 9th European IFSA Symposium, 4-7 July 2010, Vienna (Austria).

CARBERRY, P., HOCHMAN, Z., MCCOWN, R., DALGLIESH, N., FOALE, M., POULTON, J., HARGREAVES, D., CAWTHRAY, S., HILLCOAT, N. & ROBERTSON, M., 2002. The FARMSCAPE approach to decision support: farmers, advisors, researchers monitoring, simulation, communication, and performance evaluation. *Agricultural Systems. 74 (2002), pages 141 – 177.*

DARBAS, T. & LAWRENCE, D., 2011. The influence of agronomic advice upon soil water thresholds used for planting decisions in Southern Queensland's grains region. *Agricultural Systems. Volume 104, Issue 1, January 2011, pages 20 – 29.*

EASTWOOD, C., AYRE, M., NETTLE, R. & DELA RUE, B., 2019. Making sense in the cloud: farm advisory services in a smart farming future. *NJAS – Wageningen Journal of Life Sciences.* https://doi.org/10.1016/j.njas.2019.04.004.

FOOD AND AGRICULTURE ORGANIZATION (FAO). 2020. Agricultural extension in transition worldwide. Policies and strategies for reform. Viewed 14 June 2020. http://www.fao.org/3/ca8199en/ca8199en.pdf.

GOSLING, M. & MOOLLA, Y. 2011. South Africa's ever-shrinking farmers. Viewed 19 April 2020. https://www.iol.co.za/mercury/south-africas-ever-shrinking-farmers-1167943.

INGRAM, J. & MORRIS, C., 2007. The knowledge challenge within the transition towards sustainable soil management: an analysis of agricultural advisors in England. *Land Use Policy Volume 24, Issue 1, January 2007, pages 100 – 117.*

KALABA, M. 2015. The conversation on South Africa's struggling agricultural sector: what went wrong 20 years ago. Viewed 4 April 2020. https://theconversation.com/south-africas-struggling-agricultural-sector-what-went-wrong-20-years-ago-45171.

KENTON, W., 2019. What is descriptive statistics? Viewed 5 March 2020. http//:www.research-methodology.net.

KHWIDZHILI, R. & WORTH, S. 2016. The sustainable agriculture imperative: implications for South African agricultural extension. *S. Afr. J. Agric. Ext. Vol. 44, No. 2, 2016: 19 – 29.*

KHWIDZHILI, R. & WORTH, S., 2019. Evaluation of South Africa's public agricultural extension in the context of sustainable agriculture. *S. Afr. J. Agric. Ext. Vol. 47 No. 1, 2019: 20 – 35*.

KOCH, B. H. & TERBLANCHÉ, S. E., 2013. An overview of agricultural extension in South Africa. *S. Afr. J. Agric. Vol. 41, 2013: 107 – 11*.

MAKA, L. & ALIBER, M., 2019. The role of mentors in land reform projects support through the recapitalisation and development programme: findings from Buffalo City, Metropolitan municipality, South Africa. Viewed 11 May 2020. http://dx.doi.org/10.17159/2413-3221/2019/v47n2a50.

MILES, N., 2018. Dodgy soil fertility advisors cost farmers big bucks! KwaZulu-Natal Department of Agriculture and Environmental Affairs.

NETTLE, R., CRAWFORD, A. & BRIGHTLING, P., 2018. How private-sector farm advisors change. Viewed on 13 June 2020. https://www.precisionag.com/market-watch.

PORTER, C., 2015. The need for agronomists in the future: will technology take over? *Farmers Guardian*. Viewed on 10 April 2020. https://www.fginsight.com/vip/vip/the-need-for-agronomists-in- the-future-will-technology-take-over-5493.

SALEMBIER, C., SEGRESTIN, B., BERTHET, E., WEIL, B. & MEYNARD, J., 2018. Genealogy of design reasoning in agronomy: lessons for supporting the design of agricultural systems. *Agricultural Systems. Volume 164. pages 277 – 290*.

SEWELL, A., HARTNETT, M., GRAY, D., BLAIR, H., KEMP, P., KENYON, P., MORRIS, S. & WOOD, B., 2017. Using educational theory and research to refine agricultural extension: affordances and barriers for farmers' earning and practice change. *J. Agric. Educ. Ext. 23(4), 313 – 333*.

SHARMA, S., 2019. Descriptive Statistics. Viewed 22 April 2020. https://www.researchgate.net/publication/333220406_Descriptive_Statistics.

SOUTH AFRICAN COUNCIL FOR NATURAL SCIENTIFIC PROFESSIONALS (SACNASP). 2019. Annual report 2018/19. Viewed 15 May 2020. https://www.sacnasp.org.za/annual-reports 2018/19.

STATS SA, 2020. Stats SA releases census of commercial Agriculture 2017 report. Viewed on 4 April 2020. http://www.statssa.gov.za/?s=agriculture.