Original Scientific paper
10.7251/AGRENG2101026M
UDC 551.577.21:63(680)

POTENTIAL CONSTRAINT OF RAINFALL AVAILABILITY ON THE ESTABLISHMENT AND EXPANSION OF AGROFORESTRY IN THE MOPANI DISTRICT, LIMPOPO PROVINCE IN SOUTH AFRICA

Phokele MAPONYA[1*], Casper MADAKADZE[2], Nokwazi MBILI[3], Zakheleni DUBE[4], Thabo NKUNA[1], Meshack MAKHWEDZHANA[1], Takalani TAHULELA[5], Kgosi MONGWAKETSI[5]

[1]Agricultural Research Council-Vegetable and Ornamental Plant, Pretoria, South Africa
[2]University of Pretoria, Faculty of Agriculture and Natural Science, South Africa
[3]University of KwaZulu-Natal, College of Agriculture, Engineering and Science, School of Agricultural, Earth and Environmental Science, South Africa
[4]University of Mpumalanga, Faculty of Agriculture and Natural Science, South Africa
[5]South Africa Forestry Company Limited (SAFCOL) Research, SAFCOL (Pty) LTD, Sabie, South Africa
*Corresponding author: maponyap@arc.agric.za

ABSTRACT

Agroforestry is a land use system that includes the use of woody perennial and agricultural crops and animals in combination to achieve beneficial ecological and economical interactions for food, fiber and livestock production. South Africa is considered a semi – arid country vulnerable to water stress, particularly drought. Limpopo Province average annual rainfall is 600mm and the threshold for rainfall agriculture is averaged at 250mm annually. In terms of forestry, rainfall needs to be higher than 750mm per annum to sustain commercial forestry. The objective of the study was to determine the potential constraint of rainwater on the establishment and expansion of agroforestry in Mopani district, Limpopo Province. A purposive sampling technique was used to select 62 agrosilviculture community growers and were spread on the 20ha SAFCOL forestland and each grower was allocated a row of 3226m^2 (1ha = 10000m^2; 20ha * 10000 = 200000m^2/62) for production. Quantitative and qualitative designs were used. The results were based on the month the data collection started: September 2019 rainfall results indicated that there was generally good rainfall (25 - 50mm) in the agroforestry sites as compared to the agricultural open field areas. October 2019 rainfall situation improved with an increase in rainfall (51 - 100mm). During November and December 2019, increasing rainfall was experienced at 100 - 200mm and 175 - 250mm, respectively. The last three rainfall status (33rd, median & 66th percentiles) indicated the estimates of rainfall in the future years. It estimated annual rainfalls at 601 and +1000mm; +1000mm & +1000mm across 33rd, 50th & 66th percentiles, respectively. This rainfall situation is well above the Limpopo Province annual average rainfall, agriculture and forestry thresholds. Currently, the eucalyptus trees

were integrated with other crops including maize, sweet potatoes, groundnuts and bambara nuts. It is thus recommended that the establishment and expansion of agroforestry be carried out in the identified suitable areas.

Key words: *Agrosilviculture System, Rainwater, Food Security, Limpopo Province and South Africa.*

INTRODUCTION

Results from several studies have indicated that agroforestry practices are perceived in different ways. According to (Lundgren and Raintree, 1982) agroforestry is viewed as the set of land-use practices, which involves the combination of trees, agricultural crops and/or animals on the same land management unit. Nair (1993) emphasized that although cultivating trees in combination with crops and livestock is considered an ancient practice, factors such as the deteriorating economic situation in many parts of the developing world, increased tropical deforestation; incorrect agricultural practices; degradation and scarcity of land because of population pressures; and growing interest in farming systems, intercropping and the environment have contributed to a rising interest in agroforestry since the 1970s. Based on the above mentioned factors (Mercer and Miller, 1998) further acknowledged that most research on agroforestry has been conducted from the biophysical perspective, but socio-economic aspects in relation to perception of farmers should be given more attention.

Combe (1982) classified agroforestry systems into three broad groups, namely agrosilvicultural (mixing trees and crops), silvopastoralism (mixing trees, pastures and animals) and agrosilvopastoralism (mixing trees with crops and animals). According to Rethman et al. (2007) these groups can further be subdivided as either simultaneous (where trees and crops are grown simultaneously), or sequential (where trees and crops are grown separately, temporally, over a number of seasons, as with improved fallows). According to (DAFF, 2017) Agroforestry is a land use system that includes the use of woody perennial and agricultural crops and animals in combination to achieve beneficial ecological and economical interactions for food, fiber and livestock production. It is further emphasized that properly managed Agroforestry system provides multiple benefits and contribute to improved livelihoods and income generation (DAFF, 2017; Maponya *et al.*, 2018; Maponya *et al.*, 2019).

According to Hassan (2013), South Africa is considered a semi – arid country vulnerable to water stress, particularly drought. Limpopo province average annual rainfall is 600 mm and the threshold for rainfall agriculture is averaged at 250 mm annually (ARC, 2017). In terms of forestry, the plantation forests of South Africa use just 3% of the country's total water resources and rainfall needs to be higher than 750 mm per annum to sustain commercial forestry. According to ARC (2017), the relatively narrow escarpment area in the district receives an annual rainfall of 800 to more than 1000 mm. A narrow band of relatively high rainfall (700-800 mm p.a.) runs along the foot of the escarpment. The broad lowveld plain receives 400-

600 mm p.a. The rainfall is very strongly concentrated during the summer months. Summer temperatures are high over the lowveld (Tmax in January 31-34). Winter temperatures are mild over the lowveld (Tmin in July 7-10°C). Regular frost does not occur in the lowveld. The relatively high potential evaporation of 1000-1100 mm during the summer months results in most of the agricultural areas being marginally suited or unsuited to most conventional rainfed arable agriculture enterprises. The Mopani district also falls within the Levuvhu and Letaba WMA. Of the five sub-areas, two (Levuhu/Mutale and Groot Letaba) constitute important irrigation areas with high value crops. Apart from water from the new Nandoni Dam, the surface water resources are over-extended and water for irrigation is being augmented by groundwater. Hence, the objective of the study was to determine the potential constraint of rainwater on the establishment and expansion of agroforestry in Mopani district, Limpopo Province.

MATERIALS AND METHODS

All the research done so far with partners (South African Forestry Company Limited, Department of Forestry & Fisheries, Universities of Kwazulu Natal, Pretoria & Mpumalanga) is focused on achieving or working towards a participatory research approach since the researcher, collaborators, extension officers, farmers and funder were actively involved in all phases. According to Backeberg and Sanewe (2010), the method of participatory action research is most appropriate since peoples especially farmers benefit while the research is ongoing. The participatory action approach was also recommended by various researchers who emphasised that the participatory action approach is a good alternative to the traditional “transfer of technology" or ”top - down approach" to agricultural research and extension. It is against this background that the approach was used to achieve the research objective. The research used quantitative and qualitative methods. A detailed questionnaire written in English was developed as a quantitative data collection method. The qualitative data collection methods included focus group discussions and field observations. A purposive sampling technique was used to select 62 agrosilviculture community growers and were spread on the 20ha SAFCOL forestland (see figure 1) and each grower was allocated a row of 3226m^2 (1ha = 10000m^2; 20ha * 10000 = 200000m^2/62) for production. Socio economic data was analysed quantitatively using the Statistical Package for Social Sciences (IBM SPSS Statistics) windows version. The following approach was used to determine average monthly rainfall (Malherbe and Tackrah, 2003): Decadal (ten day period) 1km x1km surfaces were created from rainfall data (1920 – 1999) downloaded from the AgroMet databank at the Agricultural Research Council- Soil, Climate and Water (ARC-SCW) (South African Weather Service and SCW weather stations) from stations with a recording period of 10 years or more. Regression analysis and spatial modelling were utilized taking into account topographic indices such as altitude, aspect, slope and distance to the sea during the development of the surface.

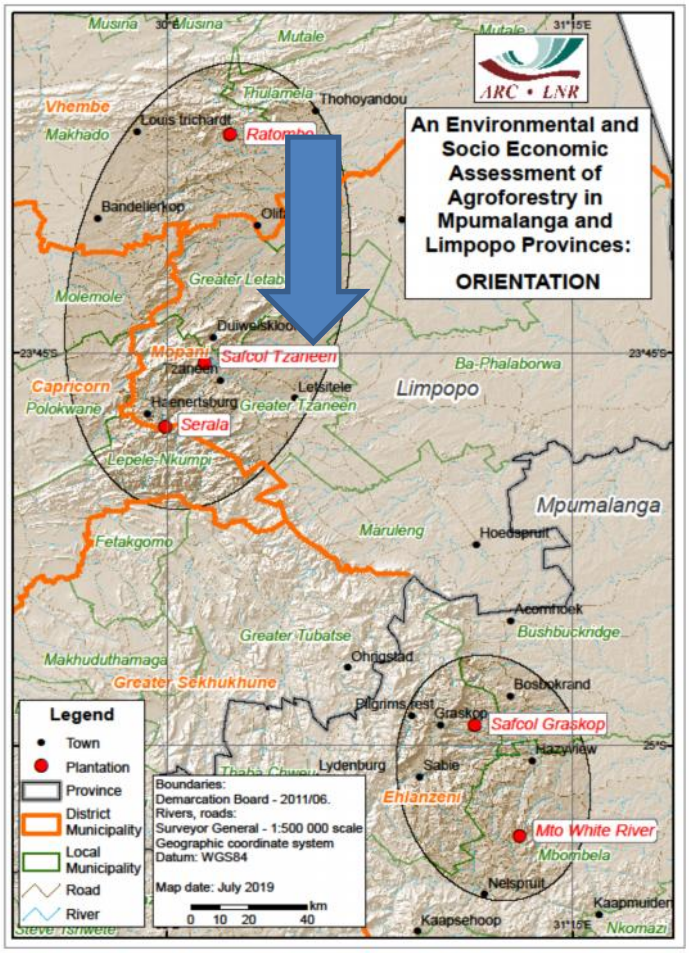

Figure 1. Location of the SAFCOL study area in Tzaneen in Mopani District.

RESULTS AND DISCUSSION

The majority of agrosilviculture community growers interviewed were female. According to Table 1, fifty-eight women were interviewed as compared to four males. In terms of educational attainment (Table 1), 1.6 % of growers had no education, 82% of growers had primary education, 15% of growers had matric while 1.6% of growers had post matric. According to (Maponya *et al.*, 2016) training and education plays an important role in smallholder farmer development and failure to address some of the training needs has led to constrained agricultural growth in some districts in South Africa (Maponya *et al.*, 2014 and Maponya *et al.*, 2015). As indicated in Table 1, all the sixty – two growers were full time engaged in agrosilviculture practice. The growers indicated that they received no training on agroforestry as they mostly relied on their indigenous knowledge system (IKS). Results on land acquisition (Table 1) indicated that the growers were allocated land

by SAFCOL for production.The agrosilviculture community growers also emphasized that they moved away from their villages to the study area in search of its good climate including rainfall. The agrosilviculture community growers indicated that they have experience (See Table 1) and have been practicing agroforestry for decades in the study area as it has improved their livelihood through income generation, job creation and food security. Currently, the eucalyptus trees were integrated with other crops including; maize, sweet potatoes, groundnuts and bambara nuts.The age distribution of the growers indicated that the majority were in the age group of >60 (73%). As indicated in Table 1, youth involvement is very low (6.5%), 36 – 45 (1.5%) while 46 – 59 had 19%. This situation is worrisome and indicates the urgent need to attract young generation into agroforestry as an important priority.

Table 1. Agrosilviculture Community Growers Selected Socio Economic Characteristics

Variables	Growers	% of Growers
Gender		
Female	58	94
Male	4	6
Total	**62**	**100**
Level of Education		
No Education	1	1.6
Primary Education	51	82
Matric	9	15
Post Matric	1	1.6
Diploma/Degree	0	0
Total	**62**	**100**
Employment Status		
Agrosilviculture Community Grower	62	100
Other	0	0
Total	**62**	**100**
Age (Years)		
18 – 35	4	6.5
36 – 45	1	1.5
46 – 59	12	19
>60	45	73
Total	**62**	**100**
Agroforestry Training		
Yes	0	0
No	62	100
Total	**62**	**100**
Agroforestry Experience (Years)		
1 – 5	25	40
6 - 10	7	11

11 - 20	12	19
21>	19	30
Total	**62**	**100**
Land Acquisition		
Own Finance	0	0
LRAD	0	0
Lease	0	0
Inheritance	0	0
SAFCOL Land	**62**	**100**
Total	**62**	**100**

Figure 2 – 8 are self-explanatory. As indicated in figure 2, the September 2019 rainfall results indicated that there was generally good rainfall (25 - 50mm) in the agroforestry sites as compared to the agricultural open field areas. As shown in Figure 3, the October 2019 rainfall situation improved with an increase in rainfall (51 - 100mm). The same trend is observed in all visited and identified agroforestry sites (Ratombo, Serala, MTO White River and SAFCOL Graskop). This situation is also not surprising, as the Department of Forestry & Fisheries (DEFF) has identified those agroforestry sites as pilots.

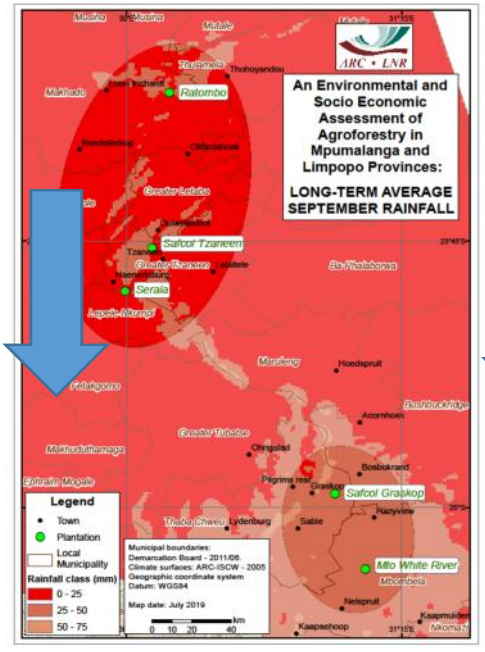

Figure 2. Average September Rainfall

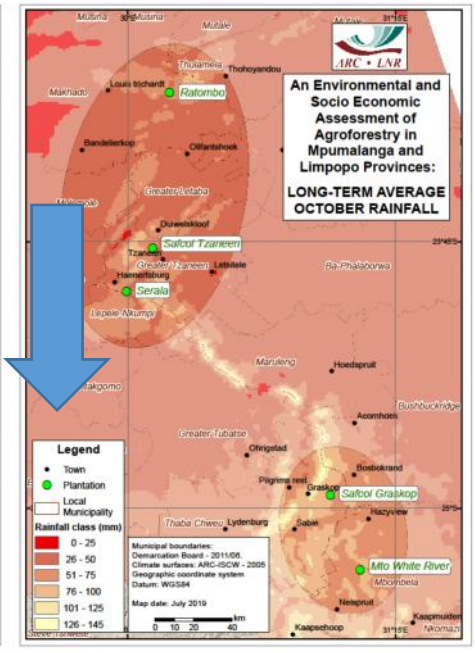

Figure 3. Average October Rainfall

As indicated in Figure 4 and 5 long-term increases in rainfall from November to December are experienced in the study area. During November and December 2019, increasing rainfall was experienced at 100 - 200mm and 175 - 250mm, respectively. The rainfall belt is seen from Ratombo Plantation (Limpopo Province) until the MTO White River (Mpumalanga Province).

This trends offers a good platform for the establishment and expansion of agroforestry as rainwater is not a constraint as compared to the open field agriculture. Hence, there is a movement of communities from their villages to the agroforestry sites in search of good climate.

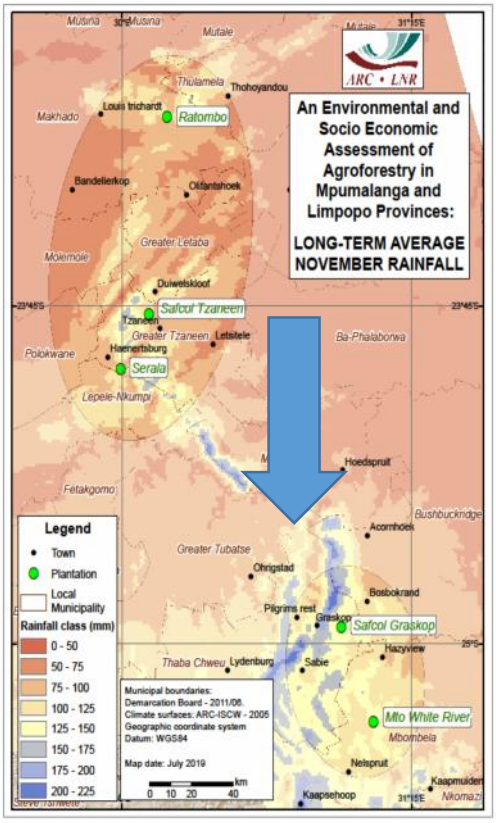

Figure 4. Average November Rainfall

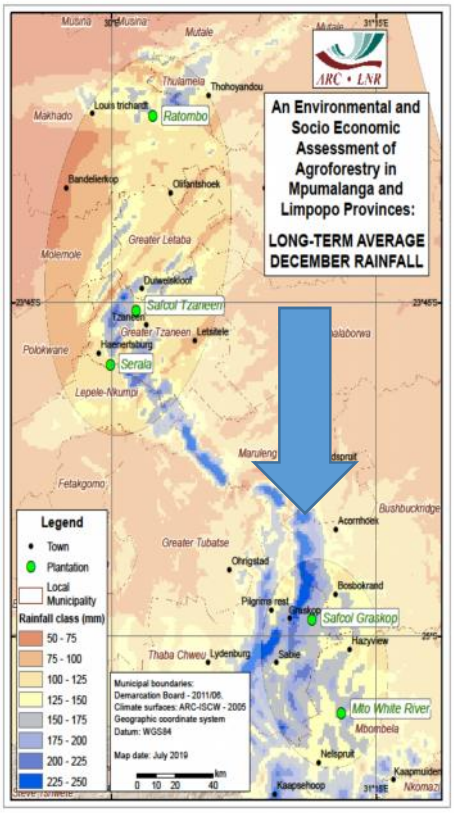

Figure 5. Average December Rainfall

The last three rainfall status (33rd, median & 66th percentiles) indicated the estimates of rainfall in the future years. It estimated annual rainfalls at 601 and +1000mm; +1000mm & +1000mm across 33rd, 50th & 66th percentiles, respectively. This rainfall situation is well above the Limpopo Province annual average rainfall, agriculture and forestry thresholds.

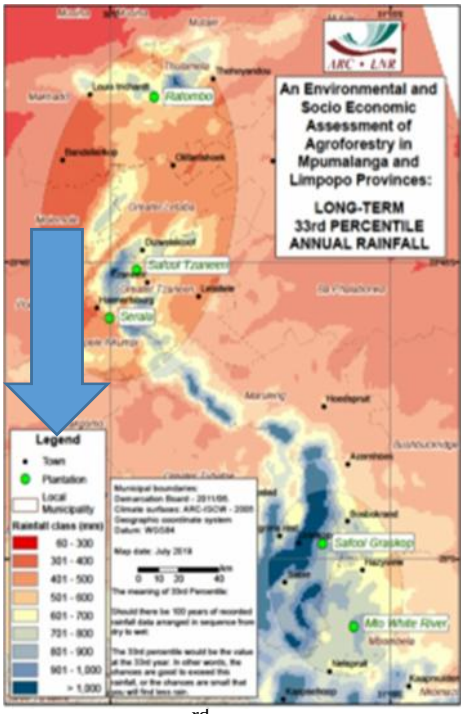

Figure 6. 33rd Annual Rainfall

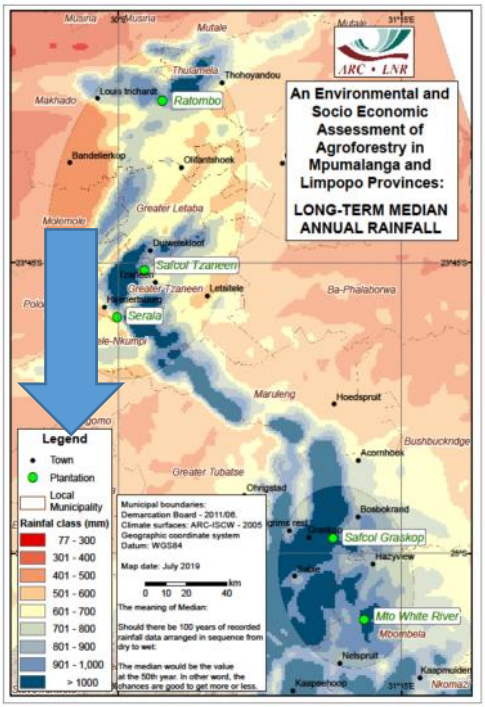

Figure 7. Median Annual Rainfall

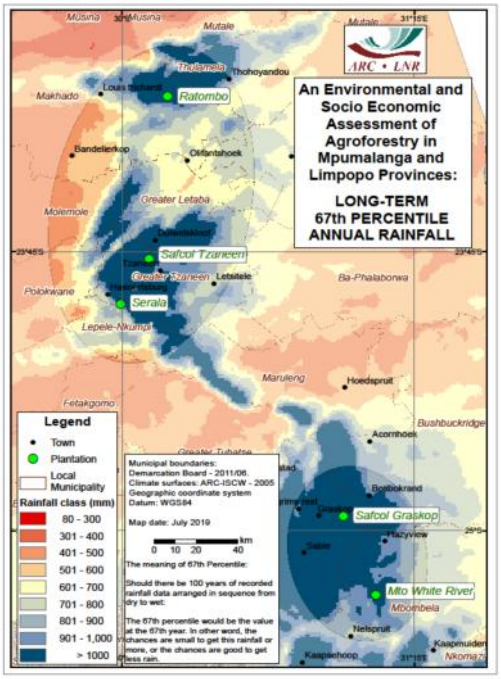

Figure 8. 67th Annual Rainfall

CONCLUSION

It can thus be concluded that rainwater is not a constraint in the study area for the establishment and expansion of agroforestry. Figures 2 – 8 confirms that rainwater is not a constraint for agroforestry establishment and expansion in the SAFCOL Tzaneen agroforestry site. The rainfall belt is also more evident in the agroforestry sites as seen in figures 6 – 8. Currently the eucalyptus trees are integrated with maize, groundnut, bambara nut and sweet potatoes and the communities are relying only on rainfall for irrigation. The study recommends that the establishment and expansion of agroforestry be carried out in the identified suitable areas and in line with the Department of Agriculture, Forestry and Fisheries Agroforestry 2017 Implementation strategy.

ACKNOWLEDGEMENTS

The authors wish to acknowledge the following: Agricultural Research Council, South African Forestry Company Limited, Department of Forestry & Fisheries, Universities of Kwazulu Natal, Pretoria & Mpumalanga. A special thanks to Ms Marjan Van Der Walt (ARC ISCW) for her excellent & professional work in drawing the climate maps.

REFERENCES

Agricultural Research Council ISCW (ARC-ISCW). (2017). Pretoria, South Africa.

Backeberg G.R., Sanewe A.J. (2010). Towards productive water use and household food security in South Africa. Paper presented at the *6th Asian Regional Conference of ICID*, 10–16 October 2010, Indonesia

COMBE J. (1982). Agroforestry techniques in tropical countries: Potential and limitations. *Agrofor. Syst.* 1 13-27.

Department of Agriculture, Fisheries and Forestry (DAFF). (2017). Agroforestry Strategy Framework for South Africa, March 2017, Pretoria.

Hassan R. (2013). Drought Management Strategies in South Africa and the Potential for Economic Policy Instruments, Book Chapter, DOI: 10.1007/978-94-007-6636-5-21

Lundgren B.O., Raintree J.B. (1982). Sustained Agroforestry. In Nestel B (ed.) Agricultural Research for Development: Potential and Challenges in Asia. ISNAR, The Hague, Netherlands

Malherbe J and Tackrah A. (2003). Long-term average ten daily 1km X 1km temperature, rainfall and evaporation grid surfaces modelled from weather station data with a long-term recording period. ARC-Institute for Soil, Climate and Water, Pretoria.

Maponya P., Venter S.L, Du Plooy C.P, Backeberg G.R, Mpandeli S.N and Nesamvuni E. (2019). Oral Presentation & Full Paper Publication, BEST PAPER AWARDED, Research, Extension Services and Training as key drivers to agroforestry adoption in Limpopo Province, South Africa, 3rd World Irrigation Forum, International Commission on Irrigation and Drainage (ICID), 01 – 09 September 2019, Bali, Indonesia.

Maponya P., Venter S.L, Du Plooy C.P, Backeberg G.R, Mpandeli S.N and Nesamvuni E. (2019). Poster Presentation & Full Paper Publication, GRANT AWARDED, Evaluation of the timber based mixed farming/agroforestry systems: A case of farmers in Limpopo Province, South Africa, 4th World Congress on Agroforestry, 20 – 22 May 2019, Montpellier, France.

Maponya P., Venter S.L, Du Plooy C.P, Backeberg G.R, Mpandeli S.N and Nesamvuni E. (2018). Oral Presentation & Full Paper Publication, Perceptions on the Constraints to Agroforestry Competitiveness: A Case of Smallholder Farmers in Limpopo Province, 9th International Scientific Agriculture Symposium, 04th - 07th October 2018, Bosnia - Herzegovonia.

Maponya P.I., Modise D., Van Den Heever E., Mahlangu S., Baloyi T., Maluleke A., Carsten J., Van Der Walt M., Chauke D., Mkhari R., Sole L., Duba M., Malebana J., Mphahlele M. (2014). Establishment of Fruits and Vegetables Markets: A case of Waterberg District in Limpopo province, *Journal of Agricultural Science* Vol. 6 (6), June 2014

Maponya P., Venter S.L., Modise D., Van Den Heever E., Kekana V., Ngqandu P., Ntanjana N ., Pefile A. (2015). Determinants of Agricultural Market Participation in the Sarah Baartman District, Eastern Cape of South Africa, *Journal of Human Ecology*, 50 (1) 1 - 9, 2015.

Maponya P., Venter S.L., Du Plooy C.P., Modise S.D., Van Den Heever E. (2016). Training challenges faced by smallholder farmers: A case of Mopani district, Limpopo province, Journal of Human Ecology, 56 (3); 272 – 282, 2016.

Mercer D.E., Miller R.P. (1998). Socioeconomic research in agroforestry: progress, prospects, priorities. Agroforestry Systems 38: 177–193

Nair P.K.R. (1993). An introduction to Agroforestry. Kluwer Academic publishers, Netherlands.

Rethman N.F.G., Annandale J.G., Keen C.S., and Botha C.C. (2007). Water use efficiency of multi – crop agroforestry systems with particular reference to small-scale farmers in semi-arid areas, Water Research Commission Report (WRC) Report No. 1047/1/07.