



***The World's Largest Open Access Agricultural & Applied Economics Digital Library***

**This document is discoverable and free to researchers across the globe due to the work of AgEcon Search.**

**Help ensure our sustainability.**

Give to AgEcon Search

AgEcon Search  
<http://ageconsearch.umn.edu>  
[aesearch@umn.edu](mailto:aesearch@umn.edu)

*Papers downloaded from AgEcon Search may be used for non-commercial purposes and personal study only. No other use, including posting to another Internet site, is permitted without permission from the copyright owner (not AgEcon Search), or as allowed under the provisions of Fair Use, U.S. Copyright Act, Title 17 U.S.C.*

*No endorsement of AgEcon Search or its fundraising activities by the author(s) of the following work or their employer(s) is intended or implied.*

**IMPACT OF WATER RESEARCH COMMISSION COWPEA PROJECT ON THE  
IMPROVEMENT OF CROPPING SYSTEMS AND NUTRITION OF FARMERS IN  
LIMPOPO PROVINCE, SOUTH AFRICA****Asiwe JNA<sup>1\*</sup>****Joseph Asiwe**

\*Corresponding author email: [joseph.asiwe@ul.ac.za](mailto:joseph.asiwe@ul.ac.za)

<sup>1</sup>University of Limpopo, Private Bag X1106, Sovenga 0727, South Africa

<https://doi.org/10.18697/ajfand.118.21995>

22770

## ABSTRACT

Two pilot surveys were conducted to assess the status of cultural practices, the diversity of crops grown and diet, training and skill development, as well as the daily diet eaten among the farmers in the study areas (Ga-Thaba and Bela-Bela). The purpose of the pre-project commencement survey (Survey 1) was to enable the project team to ascertain whether there was any gap or felt needs that the project could execute. In light of this, Survey 1 was conducted to determine the status of the cropping systems, crops grown, constraints to production, and dietary intakes in the communities at the initiation of the project. This ascertained the potential gaps or needs that the project could accomplish in the communities. The other survey, the post-project execution survey (Survey 2) was to assess whether there were positive changes or impacts at the end of the project stemming from the activities of the project in the areas of cultural practices, crop diversity, dietary intake and nutrition of farmers, training of farmers, constraints to production, utilisation and uptake of the benefits. During surveys 1 and 2, a total of 42 and 50 farmers were sampled from Ga-Thaba and Bela-Bela communities, respectively in 2015 at the initiation of the project and in 2019 at the completion of the project. Results arising from the sampled farmers indicate that from the variables measured during Survey 1, significant information or gaps as the dire needs of the farmers were identified which showed that the project was relevant for the study areas. In addition, the results from Survey 2 indicate that the project was appropriate to meet the needs of the farmers, filling the gaps identified during Survey 1. This implied that the project was successfully able to attain the stated objectives and added value to the livelihoods of the farmers in terms of crop diversification, the dietary intakes and diversity, training and skill development to empower and improve the communities on rural livelihoods, food security and nutrition.

**Key words:** Crop diversity, cowpea, dietary intake, empowerment, food security and nutrition



## INTRODUCTION

According to Labadarios *et al.* [1], the Eastern Cape, followed by Limpopo, recorded the highest numbers of citizens experiencing food insecurity. One of the ways to enhance sustainable food production and food security and nutrition in drought-prone communities in Limpopo is through the introduction and cultivation of high-yielding, disease-resistant and insect pest-resistant, early-maturing and water use efficient grain legumes such as cowpea, pigeon pea and Bambara groundnut. Cowpea and early-maturing pigeon pea are versatile crops of note, which are globally known to thrive well, even under low and erratic rainfall conditions where cereal crops cannot grow [2,3,4].

The trading and processing of seeds from cowpea provide a dependable source of livelihood for the poor in both rural and urban areas, thereby creating opportunities for earning a regular income [4,5,6,7]. Cowpea snacks and their derivatives are important traditional plant protein-rich menus prepared and sold as foods on the streets in many parts of Africa, and this can help improve the dietary intake of impoverished communities in South Africa. According to Pingali [8], the promotion of the production of cereals occasioned by the green revolution has brought about stagnation in the production and utilisation of grain legumes. However, Modi and Mabhaudhi [9] reported that the promotion and reinstatement of grain legumes is critical for the attainment of food crop diversity and nutrition in rural communities. According to them, this diversity will translate to food and nutrition security and improve the dietary intake of rural communities. Akinyele and Shokunbi [10], in their report and recommendation, maintained that the production and utilisation of grain legumes should be promoted. Labadarios *et al.* [11] reported that protein-energy malnutrition is a major concern in rural communities. Legumes are generally cheap sources of proteins, micronutrients, vitamins and minerals, and are good complements to starchy diets [5]. Shetty [12] reported that one of the ways to enhance food and nutrition security is through crop diversity and productivity.

Cowpea and pigeon pea are versatile crops of note, which are globally known to thrive well under low and erratic rainfall conditions where cereal crops cannot grow, and therefore offer great opportunities for cultivation in such drought-prone areas in South Africa. The promotion of cowpea in areas with erratic rainfall will not only increase the productivity of the farmers, but will alleviate poverty and malnutrition, and also create employment for all those involved in the value chain in cowpea production.

In Limpopo, mixed intercropping is a common cropping system where legumes are planted together with cereals without any definite row arrangement. This practice does not optimise plant density, nor does it allow the efficient management of crops using modernised equipment. It hinders the application of farm inputs and is characterised by low yields [2, 3,4, 5,6,7]. Strip intercropping is a novel practice and involves growing two or more crops together in strips wide enough to permit the separate management of crops, but close enough for the crops to interact. This cropping system has great potential in reducing inter-species competition, allowing the individual management of intercrops and optimising plant density, thereby increasing yields per unit area. However, the performance of improved cowpea varieties has not been studied in detail under a strip intercropping system with maize, in Limpopo. This offers great potential for elite cowpea varieties to be tested under this cropping system. South Africa, particularly Limpopo, is a semi-arid region, characterised by marginal soil, and low erratic rainfall. This results in reduced crop yields [13]. Therefore, introducing improved early-maturing varieties of cowpea, which are drought-tolerant, in an intercropping system to smallholder farmers will increase their productivity. The project commenced in April, 2015 and ended in February, 2020.

In view of the above introduction, the Cowpea Water Research Commission (WRC) Project on which this study hinges had the following objectives, to:

- “Introduce and promote the production of new, high-yielding, pest-resistant, water use efficient and resource-efficient grain legumes.
- Promote the transformation of existing cropping practices through the introduction of modern production practices (the strip intercropping of legumes with maize) in communities.
- Improve nutritional dietary intake of the communities through the introduction of cowpea-based food products (Akara and Moin-moin) and the fortification of their maize-sole diets with cowpea products.
- Identify the stakeholders in the cowpea value chain (cowpea production and food processing value addition) and enhance human capital development in the value chain through training and farmers' schools.
- Stimulate sustainable development through the improvement of traditional agronomic production practices, the preparation of cowpea diets and the cultivation of resource use-efficient legumes”.

Previous reports have shown that the promotion and reinstatement of grain legumes is critical for the attainment of food crop diversity and nutrition in rural

communities and that protein-energy malnutrition is a major concern in rural communities [14, 15, 16, 17]. Crop diversity and productivity initiatives should include the promotion of crops that are adapted to dry areas and are nutrient-rich, such as cowpea [18, 19].

Given the above background, the objectives of this study were to conduct a pre- and post-project commencement surveys to determine:

1. the status of the cultural practices, cropping systems, crops grown, constraints to production, training received by farmers to improve their skills and dietary intakes in communities at the initiation of the WRC cowpea project. This was to ascertain whether there were potential gaps or needs that the WRC project would fill in the communities,
2. whether there were positive changes or impacts at the end of the project cycle stemming from the cultural practices, crop diversity, dietary intakes and nutrition of farmers, training of farmers, constraints to production, utilisation and uptake of the benefits.

## MATERIALS AND METHODS

### Description of survey areas

Capricorn District is divided into five local municipalities: Aganang, Blouberg, Lepelle-Nkumpi, Molemole and Polokwane. Polokwane Local Municipality covers only 3% of Limpopo. However, over 10% of the province's population resides within its boundaries. It serves as the economic hub of the province, with Capricorn District having the highest population density. Ga-Thaba village is a rural community which falls within the Polokwane Local Municipality. It is situated South-West of Polokwane City, about 70 km from the city. Ga-Thaba is among the poorest areas in Polokwane Local Municipality. The majority of its inhabitants are subsistence farmers.

Waterberg District Municipality is made up of five local municipalities: Thabazimbi, Bela-Bela, Mookgophong, Lephalale and Mogalakwena. The district covers a total area of about 44 913 km<sup>2</sup>. Bela-Bela is the local municipality that was surveyed. The main economic sectors in the district are agriculture, tourism and mining.

### Conducting the surveys

To determine the status of cultural practices, cropping systems, crops grown, constraints to production and dietary diversity in the communities at the initiation of the project in 2015, 42 voluntary and willing farmers were sampled from two communities, Ga-Thaba and Bela-Bela. Fifteen farmers from Ga-Thaba (Capricorn



District) and 27 from Bela-Bela (Waterberg District). No ethical clearance was needed or involved. During the second survey in 2019, 50 farmers, 20 from Ga-Thaba (Capricorn District) and 30 from Bela-Bela were interviewed. The number of farmers was higher during survey 2 because more farmers joined the project during the project execution phase. Structured questionnaire was used to interview the farmers in addition to focus group discussions of agricultural extension agents (two from Capricorn District and three from Waterberg District). Local agricultural extension agents were recruited to direct the survey team to communities and also to act as interpreters/translators where necessary. Responses from the farmers were recorded and are summarised in Table 1. The survey data were analysed using simple descriptive statistics and summarised in percentages or in proportions.

## RESULTS AND DISCUSSION

### Socioeconomic characteristics of farmers and cropping practices

The response of the farmers to all the variables indicated in the questionnaire are shown in Table 1. The socioeconomic characteristics of the farmers show that the age of the farmers during pre- and post-project execution surveys was above 35 years and no young adults were involved. The respondents in the study were predominantly women (86% at Ga-Thaba and 64% at Bela-Bela, Table 1) which suggests that some were retirees, workers, or single mothers trying to eke out their livelihood to meet their family needs. With regards to the cropping practices, results show that 62% and 90% of the farmers practiced intercropping during pre- and post-project surveys, respectively, while the rest practiced mono-cropping and mixed farming. The implication of the result in Survey 1 is that farmers in Limpopo are familiar with intercropping, which might stir up the interest of the farmers to evaluate the potentials of the new technique (strip intercropping) being introduced. The significant increase in the number of farmers during Survey 2 was due to their skill acquisition, training and knowledge received during their participation on the project which was captured during Survey 1. The number of farmers engaged in monocropping, mixed farming and livestock farming decreased during Survey 2 because most of the farmers engaged in these farming systems had shifted their interest to intercropping. Farmers practice intercropping to reduce risk of crop failure associated with pests and effect of climate change, and to intensify the use of little available land for crop production.

### Diversity of crops and cropping systems

The results on the diversity of crops grown show that the major crops grown during Survey 1 were maize, vegetables and cowpea (which was the least cultivated by

farmers). Maize is a staple crop and this confirms that maize is a dominant crop in the communities and hence forms their sole diet [20,21]. Only 14% of the farmers were growing local cowpea varieties that are characterised by late-maturing, pest susceptible, low grain yield and crawling habits. This indicates that a great opportunity exists for introducing improved cowpea varieties for cultivation. Introduction and cultivation of improved water-use efficient grain legumes in rural communities will ameliorate the problem of food insecurity and malnutrition [22]. However, during Survey 2, the number of farmers cultivating maize and vegetables decreased due to increase from 14% to 94% in the number of farmers cultivating improved cowpea varieties. This implies that farmers received training on cultural practices, cropping system and acquired knowledge on cowpea production. The implication is that family consumption of cowpea will increase and enhance their crop diversity, dietary intake and nutrition [16,17, 23,24].

The cropping system shows that during Survey 1, the majority (95%) of the farmers were practicing mixed intercropping with no definite row arrangement and only 2% were on row cropping, while no farmer was practicing strip intercropping. This offers a great opportunity or room for the novel cropping system - strip intercropping to be introduced to farmers during the project execution. However, during Survey 2, 94% and 92% were practicing row cropping and strip intercropping, respectively. This implies that farmers received the awareness and benefits of strip intercropping over mixed intercropping and adopted the former which was introduced during project execution phase.

### **Constraints to crop production**

Results on constraints to production during Survey 1 show that majority of the farmers indicated that drought, insect pest (aphid and bruchid), weeds, lack of good and improved cowpea seed varieties, lack of storage facilities and organised market for their produce are important variables that limit cowpea production. This implies that the introduction of early-maturing and resource-efficient cowpea varieties and training farmers on the use of selective herbicides to tackle the problem of weeds have great potential in enhancing the productivity of the farmers [25]. In addition, it implies that the introduction of aphid- and bruchid-resistant cowpea varieties have great potential to improve the yield and quality of seeds with concurrent reduction in pest control cost [26, 27]. The percentage of the respondents that indicated that lack of improved seeds and facilities were major constraints during survey 1 declined by 31% and 40%, respectively during the survey 2. This is due to the intervention of introducing five improved cowpea varieties during the project execution phase. In addition, although weed infestation was still recorded as a challenge to crop production by all the farmers, they were

trained on how to apply and spray selective herbicides to tackle the menace of weed infestation. This will offer the farmers the capacity to cover larger hectarage instead of depending on manual weeding which is time-wasting and laborious. The concerns respondents placed on lack of cold storage declined during Survey 2 because farmers received training on post-harvest treatment of cowpea seeds with fumigants such as Gastoxin. This will protect and preserve seeds from bruchid damage during storage, thereby reducing the demand of the farmers for cold storage. On the other hand, the number of farmers that indicated market as an important constraint to production increased during Survey 2 because of the increasing concerns of some farmers that the introduction of high yielding cowpea varieties which will translate to bumper harvest would need well organized markets for their anticipated yield increase.

### **Quality traits preferred by farmers**

With regards to the quality traits preferred by farmers, during the first survey, farmers indicated that seed colour, seed size and early maturity were their preferences. This creates an opportunity for the project to provide or introduce varieties that exhibit the farmers' preferred quality traits. However, during the second survey, an average of 50 farmers (100%) preferred the same traits compared with 39 farmers during the first survey. This implies that for the project to be accepted, the varieties must possess those qualities. Hence, the famers were provided with five cowpea varieties with different quality traits, maturity (early and medium maturity cowpea) in order to meet their needs.

### **Reasons why farmers produce cowpea**

The results on the reasons why farmers produced cowpea show that during the first and second surveys, food consumption was the major reason for producing cowpea. However, during the second survey, the percentage of respondents that indicated that income generation was their main reason for cowpea production increased from 35% to 60% [5, 24]. This implies that during the project execution phase, the farmers would have actualized the potentials in producing cowpea beyond their family consumption, thus having excess for sale to generate family income. This accounts for the higher percentage of farmers who ascertained that they produced cowpea for income generation.

### **Yield per hectare and land under cultivation**

Concerning the quantity of cowpea produced per hectare, 95% of the respondents during the first survey indicated that the yield per hectare varied from 250-500 kg/ha. This indicates that there is room for improvement through the introduction of high yielding varieties or best cultural practices which the project introduced. This

implies that their production is still small scale and there is a high potential for scaling up through improved production practices and introduction of high-yielding varieties. This also shows that their production is at subsistence level and not having excess for sale. However, during the second survey, results showed that the percentage of respondents who attained higher grain yield level (700-1000kg/ha) was 70%, while 30 % achieved less than 500kg/ha. The attainment of higher grain yield level was due to the introduction of improved high yielding varieties that are resource-use efficient and improved cultural practices which the farmers received through training during the project execution phase. The amount of land cultivable by the respondents shows that 95% of the farmers during the first survey were cultivating less than one hectare as compared to 70% of the farmers who were cultivating one to three hectares of land during the second survey. This implies that farmers were practicing more intensified cropping practices such as mixed intercropping but during the second survey, some of the farmers could cultivate 1-3 hectares as a result of the training received on the use of row and strip intercropping systems which enabled them to use tractors to plant in rows for those who had large parcels of land.

### **Training and skill development received by farmers**

Results from respondents during the survey 1 on empowerment or skill development (training on cultural practices, insect pest and weed control and cowpea processing into different menus) indicate that none of the farmers received training in any of these skill development classes. This implies that training in the skill development classes is necessary to empower the farmers for enhanced productivity. The second survey shows that average of 50 farmers (100%) received training on skill development classes. The implication of the training is that farmers are empowered with necessary skills that will equip them to produce cowpea maximally and more profitably. In addition, the results show that 100% of the farmers received training on the processing of cowpea into different menus (Cowpea cake or Akara, Moin-moin, cowpea soup, porridge, Pudding et cetera) [24]. The skill acquired will enhance their uptake, diet diversity, improve their diets and nutrition thereby reducing rural malnutrition and unemployment. This implies that most of the farmers can now eat cowpea meals fortified with cereals to meet their daily nutritional requirements.

### **Food nutrients consumed by farmers**

With regards to the food nutrients consumed by the respondents, results show that 85% of them depended on carbohydrates possibly coming from maize which was their main crop. In addition, the focus group discussion contribution affirms that majority of the participants relied solely on carbohydrates as their daily diet, with



occasional addition of some vegetables (depending on availability). This implies that the introduction of various protein-rich cowpea and relevant recipes will improve their daily dietary intake and diversity [28, 29]. However, during the second survey, the percentage of respondents consuming cowpea which was introduced in the project had increased thus balancing their diet for better intake and nutrition. This implies that rural households can now eat balanced nutritious cowpea meals fortified with cereals.

## CONCLUSION

The implications drawn from the variables that the farmers responded to in the survey provided significant information that show that the project was appropriate to meet the needs of the farmers, filling the gaps identified at the commencement of the project (Survey 1). This implied that the project was successfully able to attain the stated objectives and added value to the livelihoods of the farmers in terms of crop diversification, food security, crop diversity, and the dietary diversity of people in the study areas.

## ACKNOWLEDGEMENTS

The author acknowledges the financial grant received from the Water Research Commission, South Africa (Project number K5/2494) and the support from the University of Limpopo.

**Table 1: Farmers' responses to variables taken before the project commencement in 2015 (Survey 1) and at the end of the project in 2019 (Survey 2) at Ga-Thaba and Bela-Bela**

Variable	Survey 1	Survey 2
	Number of Farmers interviewed (n=42; males =6, females=36)	Number of Farmers interviewed (n=50; males =18, females =32)
<b>Socioeconomic characteristic</b>		
All, were above 35 years old.	42 (100%) farmers were above 35 years old; gender	All, 50 (100%) farmers were above 35 years old.
<b>Cropping practices</b>		
Intercropping	26 (62%) of the farmers plant manually and cannot use tractor because there no definite row arrangement	45 (90%) of the farmers plant manually without a tractor, but can plant using row intercropping even on small plots.
Monocropping	2 (5%)	0
Mixed farming	7 (17%)	0
Livestock	3 (7%)	2 (4%)
<b>Crops grown</b>		
Maize	40 (95%)	35 (70%)
Cowpea	6 (14%) growing local cowpea varieties	47 (94%) growing five improved cowpea varieties
Dry beans	0	0
Potato	0	0
Bambara	0	0
sunflower	0	0
Vegetables	18 (43%)	30 (60%)
soybean	0	0
<b>Cropping systems</b>		
Row cropping	2 (5%)	35 (70%)
Mixed intercropping	40 (95%) of the farmers plant manually by broadcasting with low plant population	2 (4%)
Strip intercropping	0	46 (92%) of the respondents practise strip intercropping, planting in rows with optimal plant population.
Row cropping	2 (5%)	47 (94%) grow cowpea in rows and stands.
<b>Constraints to production</b>		
Drought	42 (100%)	50 (100%)
Insect Pest	42 (100%)	50 (100%)
Weeds	42 (100%)	50(100%)
Lack of Seeds of improved cowpea varieties	40 (95%)	32 (64%)
Facilities (cold storage)	42 (100%)	30 (60%)
Lack of ready markets	38 (80%)	45 (90%)



**Quality Traits preference by farmers**

Seed colour	42 (100%)	50 (100%)
Seed size	42 (100%)	50 (100%)
Early maturity	42 (100%)	50 (100%)
Dual purpose	30 (71%)	50 (100%)

**Reasons for producing cowpea**

Food	42 (100%)	50 (100%)
Income	15 (35%)	30 (60%)
Leisure	0	0

**Quantity of yield per hectare**

250 -500kg/ha	40 (95%)	15 (92%)
700-1000kg/ha		35 (70%)
Hectrage	40 (95%), less than 1 ha	35 (70%), 1-3 ha

**Empowerment, Training and Skill development received on:**

Cultural practices	42 (100 %); No	50 (100%), Yes
Insect Pest control	42 (100 %); No	50 (100%), Yes
Weed control	42 (100 %); No	50 (100%), Yes
Cowpea processing into different menus	42 (100 %); No, they could not prepare different cowpea menus (cowpea cake or Akara, Moin-moin, soup, porridge, pudding )	50 (100%), Yes, they can prepare different cowpea menus (cowpea cake or Akara, Moin-moin, soup, porridge, pudding) fortified or in combination with other cereals.

**Food consumed by farmers**

Carbohydrates	38 (85%)	40 (80%)
Protein	12 (28%)	35 (70%)
Vegetable	24 (56%)	29 (58%)



## REFERENCES

1. **Labadarios D, Mchiza Z, Steyn P, Gericke G, Mauder E, Davids Y and W Parker** Food security in South Africa: a review of national surveys. *Bulletin of World Health Organization* 2011; **89**: 891-899.
2. **Asiwe JAN** Needs assessment of cowpea production practices, constraints utilisation in South Africa. *African Journal of Biotechnology* 2009; **8**: 5383-5388.
3. **Asiwe JNA and KS Madimabe** Performance and economic prospect of pigeonpea varieties in pigeonpea-maize strip intercropping in Limpopo Province. *International Journal of Agriculture & Biology* 2020; **25**: 20-26.
4. **Asiwe JNA and KA Maimela** Assessment of productivity variables of cowpea (*Vigna unguiculata*) varieties in cowpea-maize (*Zea mays*) strip intercropping in Limpopo Province, South Africa. *Research On Crops* 2021; **22(3)**: 516-525.
5. **Asiwe JAN, Oluwatayo IB and DN Asiwe** Enhancing food security, nutrition and production efficiency of high-yielding grain legumes in selected rural communities of Limpopo Province, South Africa: Vol. 1: Research Report and Capacity Building. *WRC Report 2020a*; No. TT 829/1/20 ISBN 978-0-6392-0176-4, pp. 191.
6. **International Institute of Tropical Agriculture (IITA)**. Cowpea-driving a silent revolution in Nigeria. Press release 2011.
7. **Asiwe JNA and KA Maimela** Assessment of productivity variables of cowpea (*Vigna unguiculata*) varieties in cowpea-maize (*Zea mays*) strip intercropping in Limpopo Province, South Africa. *Research on Crops* 2021; **22(3)**: 516-525.
8. **Pingali PL** Green revolution: Impacts, limits, and the path ahead. *Proceedings of the National Academy of Science in the United States of America* 2012; **109**.
9. **Modi AT and T Mabhaudhi** Determining water use of indigenous grain legume food crops. *WRC Report 2017*; No. 1771/1/13, Water Research Commission, Pretoria, South Africa 2017.
10. **Akinyele IO and OS Shokunbi** Concentrations of Mn, Fe, Cu, Zn Cr, Cd, Pb, Ni in selected Nigerian tubers, legumes and cereals and estimates of the adult daily intakes. *Food Chemistry* 2015; **173**: 702-708.



11. **Labadarios D, YD Davids, Z Mchiza and G Weir-Smith** The assessment of food insecurity in South Africa. Human Sciences Research Council, South Africa 2009.
12. **Shetty P** From food security to food and nutrition security: Role of agriculture and farming systems for nutrition. *Current Sciences* 2015; **109**: 456–461.
13. **Mpandeli S, Nesamvuni E and P Maponya** Adapting to the impacts of drought by Smallholder farmers in Sekhukhune District in Limpopo Province, South Africa. *Journal of Agricultural Science* 2015; **7(2)**: 115–130.
14. **Khan MA** (1987) Nutritional attributes of food legumes. *Progress. Farming*.
15. **Massawe FJ, Mayes S, Cheng A, Chai HH, Cleasby P and R Symonds, WHK Ho, A Siise, QN Wong, P Kendabie, Y Yanusa, N Jamalluddin, A Singh, R Azaman and SN Azam-Ali** The Potential for Underutilised Crops to Improve Food Security in the Face of Climate Change, *Procedia Environmental Sciences* 2015; **29**: 140–141.
16. **Graeub B, Chappell M, Wittman H, Ledermann S, Kerr R and B Gemmill-Herre** The state of family farms in the world. *World Development* 2015; **87**: 1-15
17. **Mcdermott J, Johnson N, Kadiyala S, Kennedy G and AJ Wyatt** Agricultural research for nutrition outcomes rethinking the agenda. *Food Security* 2015; **7**: 593–607.
18. **Chivenge P, Mabhaudhi T, Modi AT and P Mafongoya** The potential role of neglected and underutilised crop species as future crops under water scarce conditions in sub-Saharan Africa. *International Journal of Environmental Resources, Public Health* 2015; **12**: 5685–5711.
19. **Mayes S, Ho WK, Chai HH, Gao X, Kundy AC and KI Mateva** Bambara groundnut: an exemplar underutilised legume for resilience under climate change, *Planta Springer Verlag* 2019; **250(3)**: 803 – 820.
20. **Steyn NP, De Villiers A and N Gwebushe** Did HealthKick, a randomised controlled trial primary school nutrition intervention improve dietary quality of children in low-income settings in South Africa? *BMC Public Health* 2015; **15(1)**: 948.

21. **Kornher L** Maize markets in Eastern and Southern Africa (ESA) in the context of climate change. The state of Agricultural commodity market. Background paper Rome, FAO 2018; Pp. 58.
22. **Modi AT and T Mabhaudhi** Water use and drought tolerance of selected traditional crops. WRC Report 2013; No. 1771/1/13, Water Research Commission, Pretoria, South Africa.
23. **Ebert A** Potential of Underutilized Traditional Vegetables and Legume Crops to Contribute to Food and Nutritional Security, Income and More Sustainable Production Systems. *Sustainability Multidisciplinary* 2014; **6(1)**: 319–335.
24. **Asiwe JAN, Oluwatayo IB and DN Asiwe** Enhancing food security, nutrition and production efficiency of high-yielding grain legumes in selected rural communities of Limpopo Province, South Africa: Vol. 2: Production Guide, Training of Farmers and Cowpea Processing, and Capacity Building. *WRC Report 2020b*; No. TT 829/2/20 ISBN 978-0-6392-0176-4, Pp 62.
25. **Modi AT and T Mabhaudhi** Determining water use of indigenous grain legume food crops. *WRC Report 2017*; No. 1771/1/13, Water Research Commission, Pretoria, South Africa.
26. **Singh BB and H Ajeigbe** Improved cowpea-cereals-based cropping systems for household food security and poverty reduction in West Africa. *Journal of Crop Improvement* 2007; **19(1–2)**:157–172.
27. **Asiwe JAN, Sekgobela MM and PP Modiba** Heritability for morphological traits determine Adaptability of Elite Cowpea Genotypes in different environments. *International Journal of Agriculture & Biology* 2021b; **26(1)**: 105-114.
28. **Giami SY, Akusu MO and IR Jaja** Production, organoleptic assessment and nutritional properties of Akara from cowpea/maize flour blends. *Plant Foods for Human Nutrition* 2003; **58**: 1–9.
29. **Labadarios D, Steyn NP and J Nel** How diverse is the diet of adult South Africans? *Nutrition Journal* 2011; **10**: 33.  
<http://www.nutritionj.com/content/10/1/33>