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Productivity and profitability of sweet potato (*ipomoea batatas l.),* dry bean *(Phaseolus Vulgaris) and* maize *(Zea mays l.) as* selected field crops in irrigated smallholder agricultural enterprises (ISAEs) in Vhembe District, Limpopo Province, South Africa

[12]Tsumbedzo J. Mavhungu, [1]Azwihangwisi E. Nesamvuni, [12]Khathutshelo A. Tshikolomo, [13]Ndivhudzannyi S. Mpandeli, and [1]Johan van Niekerk

[1]Centre for Sustainable Agriculture, University of the Free State, Bloemfontein, 9300, South Africa, [2]Limpopo Department of Agriculture and Rural Development, Private Bag X9487, Polokwane, 0700, South Africa, [3]Water Research Commission of South Africa, Private Bag X03, Gezina, 0031, South Africa

nesamvunie@gmail.com

Abstract. The study was conducted as part of assessing the productivity and profitability of irrigated smallholder agricultural enterprises in the Vhembe district. Agro-ecological conditions at Upper Mutale valley (sub-humid) and Madimbo Corridor smallholder irrigation schemes (semi-arid) are significantly different. This confirms that the variables of smallholder irrigation schemes are affected by diversity and similarities attributed to different livelihood needs. The purpose of the study was to assess the influence of productivity and profitability on irrigated smallholder agricultural enterprises in the Vhembe District. A representative sample was based on the number of irrigated smallholder irrigation entrepreneurs per irrigated smallholder irrigation production area within the two identified agro-ecological zones. Primary data were collected using a questionnaire and village walk (observation). At least 294 women and youth smallholder irrigation entrepreneurs were sampled for interviews and prompt responses on the influence of productivity and profitability of selected field crops (Dry bean, Sweet Potatoes and Maize) on irrigated Smallholder Agricultural Enterprise. The study applied both primary and secondary data collection instruments. An average selected mean output of irrigated smallholder agricultural product were determined. The results through comparison between informal and formal markets show that the ISAEs who rely on the informal market is making more profit than the formal market. In selling through the formal market, the market deducts 5% of commission while the market agent deducts 7.5% of sales on the gross value of the sold product. This doesn't include the transportation charges to the market. The Farm Gate market opportunity seems to be the most predominant approach of marketing at ISAEs. These results re-affirms that ISAEs can also be alternative employment to Women and Youth who remain at home while their counterpart is looking for employment in cities. In the end, the study provides strong motivation on socio-economic impact assessment examines how an irrigated smallholder agricultural area has and will change the lives of current and future residents of a community and its local economy.

Keywords. irrigated smallholder agricultural entrepreneurs, socio-economic impact, informal and formal market, field crops

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1. Introduction

Irrigated Smallholder Agricultural Enterprises (ISAEs) have failed to reduce operator poverty and to use land and water resources sustainably. The failure has been attributed to various reasons, and those ranged from limited production and other operator skills to poor market access (Bjornlund, van Rooyen, & Stirzaker, 2017; Stirzaker & Pittock, 2014). The entrepreneurs operating the ISAEs mostly started their agribusinesses using their own or family capital and built the enterprises up over time.

According to World Bank (2005), an estimated 78 per cent of the world's extreme poor (with incomes of less than an equivalent of USD 1.25 per person per day) lived in rural areas and most of them were involved in farming. Although poverty continued to decline in many countries, major progress was yet to be made in rural parts of Sub-Saharan Africa and South Asia, and these are areas where large proportions of the population were extremely poor and dependent on smallholder farming (FAO, 2012). The establishment of ISAEs was therefore important for the promotion of food security and household incomes. Continued establishment and improved operation of ISAEs therefore positively impacted the livelihoods of the poor through increased food availability and farming incomes, and this tended to be influenced by the types of crops planted. The objective of the study was to assess the productivity and profitability of sweet potato (*ipomoea batatas l.)*, dry bean *(Phaseolus Vulgaris) and* maize *(Zea mays l.)* as major crops produced in ISAEs in Vhembe District of Limpopo Province.

2. Methodology

2.1 Locality

The study was conducted at the Vhembe district in Limpopo Province, specifically in the Madimbo corridor and Upper Mutale valley irrigated smallholder agricultural area. The Agroecological conditions in these areas are significantly different (figure 1). The conditions at Upper Mutale valley is sub-humid and the Madimbo corridor smallholder irrigation scheme is semi-arid. The semi-arid area is characterized by a severe lack of water resources to the extent of limiting agricultural production. Such a lack is brought forth by the predominance of the evapotranspiration to the rate of the precipitation (Derya, Mehmet, Süha, Sermet, and Tomohisa., 2009). Agricultural production in this category is impossible with the exception where there is irrigation.

This area is characterized by low erratic mean annual rainfall patterns which are the main factors that hinder farming in the semi-arid regions. Griffins (1985), defines the semi-arid regions as an area whose evapotranspiration supersedes the potential precipitation. Consequently, the Madimbo corridor often experiences extended spells of the dry season and shorter wet periods. In the same logic, Upper Mutale alley which is Semi-Humid areas are ideal agricultural zones. Farming in this area is possible with the sole dependence on rain-fed practices. However, these areas are not immune to drought. Dry spells are however infrequent.

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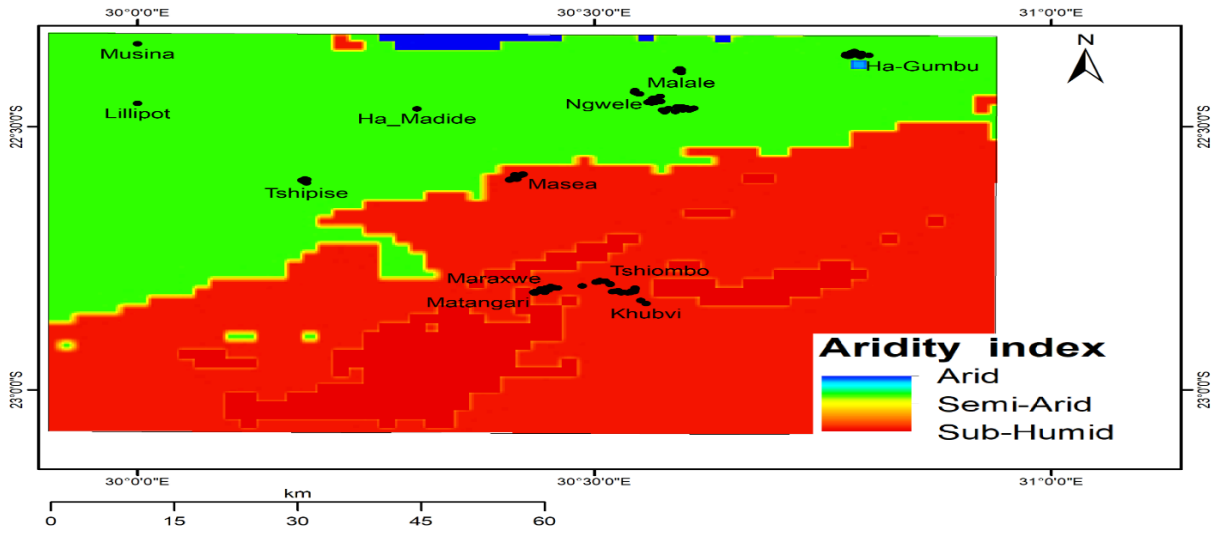

Figure 1: Aridity Index in the Madimbo Corridor Villages and the Mutale Valley.

The total irrigated smallholder agricultural hectares at the Madimbo corridor are estimated to be above 1000 ha. This irrigated smallholder agricultural enterprise obtains bulk water from the Nwanedi-Luphephe Dams. The above-mentioned dam release water to the Cross dam (Gondoza dam). The Cross dam provides balancing storage and also distribute water to irrigated smallholder agricultural enterprises using different electric pumps which belongs to each farmer. On the other side of the Madimbo corridor which is the Gumbu area, they depend on the underground water only because there is no river next to the production area. Irrigated smallholder agricultural area at Upper Mutale Valley is also estimated to be above 1270 ha. It obtains its bulk water from the Mutale River. The water weir is used to distribute water to irrigated smallholder agricultural enterprises using canal irrigation water at Upper Mutale Valley. The two areas of irrigated smallholder agricultural production area is categorized differently i.e. Madimbo corridor is categorized as independent irrigated agricultural entrepreneurs where each depends on private water supply, and at Upper Mutale Valley, the independent irrigated agricultural entrepreneurs are served by communal water supply infrastructures.

2.2 Sample Frame and Sampling Procedure

2.1.1. Sample Frame

Welman, Kruger, and Mitchell, (2005), define a sampling frame as a complete list of units of analysis in which each unit is mentioned only once. The sampling frame for this study was conducted at the Vhembe district of Limpopo province, in Thulamela and Musina Local Municipality. Two smallholder irrigation schemes were identified in these two local municipalities, namely, the Madimbo corridor irrigation scheme and the Upper Mutale Valley irrigation scheme. Madimbo Corridor irrigation schemes form part of Ha-Gumbu, Malale, Masea, Ngwele, Tshipise, Masea and the Musina – Nwanedi villages and Upper Mutale Valley cover area such as Tshiombo, Matangari, Maraxwe Mutshenzheni and Rambuda villages. A representative sample was based on total women and youth ISAEr available in both smallholder irrigation schemes. A total of 294 women and youth ISAEr after sampling were available for interview.

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2.1.2. Sample procedure

In order to ensure proper selection of respondents chosen in such a way that they represent the total population as good as possible, a two-stage simple random sampling process was conducted using *SURVEYSELECT* procedure of SAS. According to Statistical analysis system (SAS), 2009, PROC *SUREVEYSELECT* allows selection of probability-based random sampling where sampling in different categories or classes depends on the number of units within that class and is appropriate for handling selection bias. This includes primary area selection of municipalities (both district and local municipalities), location selection of irrigation schemes and respondents' selection of ISAEr.

In simple random sampling, study units are chosen, as the name implies, randomly. A simple random sampling was used to select respondents and a total unit of 294 was randomly selected for this study. In this total number of 294, adult women were 223 and youth were 71. Out of 294 as a total number, 15 were male youth and 279 were females (adult and youth). This means that the female youth was 56. The respondents were also selected with an emphasis on gender and age. Youth were considered to be of the age between 18 to 35 years. The numbers were (a) Youth female (age 18 – 35 years) were N=56; youth male (age18 – 35 years) were N=15, Adult-female (age 36 – 59 years) were N= 153 and Pensioner-female (age above 60) were N=68. Sampling was done as a process of selecting units from a population of interest, so that by studying the sample, the results obtained from the sample may be generalized to the population from which the sample had been chosen (Leedy and Ormrod, 2010). In the case of time for sampling, the best time was immediately after harvest when the farmers still remember most of the information that happen during the production period.

2.2. Data Collection and analysis

The study applied both primary and secondary data collection instruments. Primary data were collected using a questionnaire and village walk (observation). The questionnaire was developed to collect both qualitative and quantitative data. A semi-structured questionnaire was used to collect ISAEr primary data at these two smallholder irrigation schemes. The questionnaires were administered on face-to-face interviews which embrace both open- and close-ended questions.

As revealed by Leedy and Ormrod (2010), the closed-ended questions collected quantitative data while the open-ended questions recorded qualitative data. The questionnaire was developed based on the productivity and profitability of field crops in irrigated smallholder agricultural enterprises. The path village and smallholder irrigation scheme walk is a primary data collecting instrument through carrying out physical observation of points of interest related to productivity and profitability of field crops in irrigated smallholder agricultural enterprises. The walk was carried out with a group of representatives from the Madimbo corridor irrigation scheme and Upper Mutale Valley irrigation scheme who explained relevant social and economic aspects of their irrigation schemes. During the walk, the physical observations regarding productivity and profitability of field crops in irrigated smallholder agricultural enterprises were noted. Some of the noted physical observations regarding productivity and profitability of field crops in irrigated smallholder agricultural enterprises verified the information furnished on the questionnaire. Informal interviews with people encountered on the way also form part of primary data collected. In many cases, it was useful to have informal talks with ISAEr who visit, or persons accompanying the walk to further probe into examples of how ISAEr survived through smallholder irrigation schemes.

For Secondary data collection, existing related documents were collected from some NGOs offices, government departments and ministries, academic or research institutions,

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journals and use of the personal advantage to contact the scholars, researchers, and friends who have done their research concerning these issues to get in-depth understanding about this study. The above-related documents and information collected also served as guarding the information furnished by ISAER. Quantitative data were transcribed into MS Excel Package and analyzed statistically using the Statistical analysis system (SAS) Package. The Procedure FREQ of SAS was used to generate simple frequency tables for variables of interest. Selected data were summarized in Excel spreadsheet. Descriptive analysis techniques were used in the study to capture the perceptions of respondents mainly the qualitative data.

3. Results and Discussion

3.1. Contextualization of the Productivity and Profitability of Selected Field Crops Cultivated by ISAEs

Irrigated smallholder agricultural enterprise in the Limpopo Province, particularly in the Vhembe district produces field crops as one of their staple foods. This would require among other things paying special attention to improving the productivity and profitability of these field crops. Raising irrigated smallholder agricultural productivity is necessary if the production area is to overcome the problems of poverty and food insecurity. An important question to address in smallholder agriculture is whether Irrigated smallholder agricultural enterprise provides sufficient income for household livelihood.

In this study, Maize, Dry Beans, and Sweet Potatoes were selected as the main field crops produced in the Vhembe district. Nwanedi (Madimbo corridor) and Tshiombo (Upper Mutale Valley) irrigated smallholder farming area produce summer field crops even in winter production because the area is warm in winter and there is no frost occurrence. Therefore, the comparison of the influence of productivity and profitability of Irrigated Smallholder Agricultural Enterprise will be between winter production and summer production of the same field crops. This will determine which selected field crop influences productivity and profitability of Irrigated Smallholder Agricultural Enterprise in which production season.

3.2. The Objective of Cultivating Selected Field Crops.

Maize, Dry beans and Sweet Potatoes are the most important field crops in South Africa and are produced in many parts of the country under diverse environments. In this many parts of the country, field crops are produced mainly for consumption due to their high protein content, starch and dietary benefits.

Table 1 Uses of selected crops (maize, dry beans and sweet potatoes) produced in Irrigated Smallholder Agricultural Enterprises in Vhembe District of Limpopo Province.

Crop Use	**Winter**						**Summer**					
	Maize		**Dry Beans**		**Sweet Potatoes**		**Maize**		**Dry Beans**		**Sweet Potatoes**	
	f	***%***	***f***	***%***	***f***	***%***	***f***	***%***	***f***	***%***	***f***	***%***
Mainly own consumption	0,0	0,0	1,0	1,0	0,0	0,0	7,0	3,5	1,0	7,7	1,0	1,9
Exclusively own consumption	1,0	2,1	2,0	2,1	0,0	0,0	6,0	3,0	0,0	0,0	0,0	0,0
Exclusively sale	6,0	12,5	29,0	29,9	5,0	9,4	50,0	25,1	4,0	30,8	7,0	13,5

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Mainly sale	40,0	83,3	62,0	63,9	48,0	90,6	136,0	68,3	8,0	61,5	44,0	84,6
Non-response	1,0	2,1	3,0	3,1	0,0	0,0	0,0	0,0	0,0	0,0	0,0	0,0
Total	**48,0**	**100,0**	**97,0**	**100,0**	**53,0**	**100,0**	**199,0**	**99,9**	**13,0**	**100,0**	**52,0**	**100,0**

Irrigated smallholder agricultural entrepreneurs were identified as producers for mainly home consumption and for income, which may be used for the supplement at Irrigated smallholder agricultural entrepreneur's household. These are smallholder entrepreneurs in loose value chains in Irrigated smallholder agricultural produce for home consumption with added income. Some are smallholder farmers who are market-oriented and are in tight value chains that produced field crops mainly for income and leftovers for home consumption. Household income through farming is a strong determinant of the access and use of agricultural resources (Tshikolomo, Nesamvuni, Stroebel, and Walker, 2012) and subsequently of agricultural productivity. Irrigated Smallholder agricultural enterprises may develop a continuous effort to obtain higher production per unit area to increase profitability, on the one hand, and to meet the ever-increasing demand for food, form a key staple and poverty-relief crop in the Vhembe district.

Maize is consumed directly and serves as a staple diet for some 200 million people, whereas, most people regard maize as a breakfast cereal (DAFF, 2003). In Table 1 above winter production, most participants cultivate maize (83,3%) and cultivate them mainly for sale. Those who cultivate beans (63,9%) cultivate them mainly for sale, whereas in cultivating sweet potatoes (90,6%) cultivate them mainly for sale. Most irrigated smallholder agricultural entrepreneurs who cultivate maize (68,3%) in summer cultivate them mainly for sale. Those who cultivate beans (61,5%) cultivate them mainly for sale, whereas in cultivating sweet potatoes (84,6%) cultivate them mainly for sale (Table 1). In a comparison of the results of this study, we can easily categorize the ISAEs as those that are market-oriented and are in loose value chains that produced field crops mainly for income and leftovers for exclusively own consumption. The value chains are loosely based on proximity to the market, infrastructure and also transport costs. According to DAFF (2011), roadside stands, farmers' markets and local stores are other possible markets for sweet potatoes in ISAEs. The lower local supply rate and high demand for dry beans in South African markets usually result in a realistic price increase (DAFF, 2010).

Agriculture is deeply interconnected with weather and climate, as the main drivers of agricultural production, but also the dominant factors in the overall variability of food production (Selvaraju, Gommes, and Bernardi., 2011). Based on the percentages, production in the irrigated smallholder agricultural entrepreneurs was higher in winter than in summer for the selected field crops. This may be due to high temperatures that are experienced in the production area in summer. The other reason may be too expensive to cultivate field crops in summer due to lots of pesticides and fungicides required to produce certain crops due to rain and high temperatures. The reason for more products in winter maybe because the environment is suitable during winter. After all, the temperature is warm and no frost is experienced in this area.

3.3.Seasonal Variation in Fertilizer Use to Cultivate Selected Field Crops

According to Crosby, de Lange, Stimie, & van der Stoep, (2000), the interaction of moisture supply and nutrient supply is reciprocal: "if the farmer cannot irrigate, it is a waste to fertilize; if a farmer cannot fertilize, it is a waste to irrigate." Thus, if small-scale irrigation farmers are

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to realize higher yields, there should be a balance between water application and fertilizer management. Therefore, for cropping systems to remain productive and sustainable, it is necessary to replenish the nutrients removed from the soil.

Irrigated smallholder agricultural enterprise imposes a great demand for fertilizer nutrients and most crops grown in ISAEs are field crops that take large quantities of nutrients from soils. The results of this study indicated that the majority of the ISAEs combined the application of manure and chemical fertilizers in winter which was in the order of 72,9% of maize, 86.6% of Dry bean, and 79.2% for Sweet potatoes respectively. There are no significant changes in summer as 79,9% of maize, 61.5% of Dry bean, and 88.5% for Sweet potatoes (Table 2). According to Siambi, Mpandeli, Simalenga, Mkhari, and Ramugondo, (2009), soil fertility management has emerged over the past years to be the main management constraint responsible for the very poor yields obtained in Africa. Insiza District had a higher proportion (58.3%) of households that used manure in the 2004/05 season followed by Gwanda (31.6%) (Siambi *et al*., 2009). Despite the high levels of awareness on mineral fertilizer use the proportion of ISAEr households that have used fertilizer at least once remain limited.

In South Africa, for example, most households learnt about the use of manure from other neighbouring farmers and their parents (Mpandeli and Maponya, 2014; Siambi *et al*., 2009). Considering the issue of unaffordability of chemical fertilizers, plot holders in ISAEs would likely use alternative materials such as manures. The extent of use of manure would be influenced by availability in nearby communities

Table 2 Types of fertilizers used for selected crops (maize, dry beans and sweet potatoes) produced in Irrigated Smallholder Agricultural Enterprises in Vhembe District of Limpopo Province.

Fertiliser used	**Winter**						**Summer**					
	Maize		**Dry Beans**		**Sweet Potatoes**		**Maize**		**Dry Beans**		**Sweet Potatoes**	
	f	***%***	***f***	***%***	***f***	***%***	***f***	***%***	***f***	***%***	***f***	***%***
Manure	7,0	14,6	3,0	3,1	8,0	15,1	32,0	16,1	5,0	38,5	3,0	5,8
Chemical[1]	4,0	8,3	7,0	7,2	3,0	5,7	5,0	2,5	0,0	0,00	3,0	5,8
Combined[2]	35,0	72,9	84,0	86,6	42,0	79,2	159,0	79,9	8,0	61,5	46,0	88,5
Non-response	2,0	4,2	3,0	3,1	0,0	0,00	3,0	1,5	0,0	0,00	0,0	0,00
Total	**48,0**	**100,0**	**97,0**	**100,0**	**53,0**	**100,0**	**199,0**	**100,0**	**13,0**	**100,0**	**52,0**	**100,1**

[1]Chemical fertilizers = Inorganic Fertilizers, [2]Combined = combined use of manure and inorganic Fertilizers

3.4.Seasonal Variation in Pesticides Use to Cultivate Selected Fields Crops

Effective management of crop pests and diseases is critical for the success of ISAEs. The focus of the study was to assess the extent of the use of pesticides in the selected field crops in ISAEs as these have a strong influence on crop yields. Irrigated Smallholder agricultural enterprise which is located in tropical areas with high pest pressure, leads to heavy use and reliance on pesticides over traditional methods of pest control. This presents several challenges.

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Considerable evidence links pesticide uses to chronic health problems in farmers, and pesticides are known to bio-accumulate in soil and water and also be very harmful to ecosystems and wildlife.

Table 3 Pesticide use on selected crops (maize, dry beans and sweet potatoes) produced in Irrigated Smallholder Agricultural Enterprises in Vhembe District of Limpopo Province.

Was any pesticide used?	**Winter**						**Summer**					
	Maize		**Dry Beans**		**Sweet Potatoes**		**Maize**		**Dry Beans**		**Sweet Potatoes**	
	f	***%***	***f***	***%***	***f***	***%***	***f***	***%***	***f***	***%***	***f***	***%***
Yes	47,0	97,9	87,0	89,7	52,0	98,1	189,0	95,0	12,0	92,3	50,0	96,2
No	0,0	0,0	8,0	8,2	1,0	1,9	4,0	2,0	1,0	7,7	1,0	1,9
Non-response	1,0	2,1	2,0	2,1	0,0	0,0	6,0	3,0	0,0	0,0	1,0	1,9
Total	**48,0**	**100,0**	**97,0**	**100,0**	**53,0**	**100,0**	**199,0**	**100,0**	**13,0**	**100,0**	**52,0**	**100,0**

According to Fanadzo, Chiduza, and Mnkeni, (2010) citing Machete, Mollel, Ayisi, Mashatola, Anim, and Vanasche, (2004) report, indicates that the report seems to suggest that farmers had the chemicals to control all these pests, but does not clarify how effective the control was, in terms of application time and effectiveness. In Table 3, Both participants in Winter and summer production use chemicals for pest and disease control maize (97.9%), Dry bean (98.1%) and Sweet potato (89.7%) in winter while in summer maize (95.0%), Dry bean (92.3%) and Sweet potato (96.2%) respectively. As noticeable by Ngowi, Mbise, Ijani, London, and Ajayi, (2007); and Smart, Snyder, Goeb, and Tschirley, (2018)., smallholder farmers operate within a lax regulatory environment, and many do not possess adequate knowledge of optimal spray regimens or safety behaviour. Thus, most do not take adequate safety precautions.

3.5.Seasonal Variation in the Market Share of Selected Vegetable Crops

With the policy of commercialization of smallholder agricultural farmers from 2004 government managed to increase the participation of the same farmers to available markets from farm gate to retail and fresh produce markets (Nesamvuni Oni, Odhiambo, and Nthakheni, 2003). This was coupled with policy instruments such as the farmer's support policy which is approved in 2016. The policy covers Production input support such as seeds. Fertilizer, Pesticides etc., On-farm infrastructure support such as irrigation systems, Pack-sheds, ablution facilities etc., Mechanization support, Anchor marketing support such as packing and packaging facilities, processing facilities etc., and mentorship and training of farmers. The policy has the main objective of increased production of strategically identified commodities. Marketing plays a serious part in meeting the overall goal of food security, poverty alleviation and sustainable agriculture mainly among small-scale farmers in emerging countries (Altshul (1998) and Lyster (1990). As stated by Makhura, (2001), marketing by small-scale producers is inhibited by deprived infrastructure, distance from market, deficiency of assets and transport and insufficient market material. The challenge that affects vegetable production is the incapability of small-scale farmers to enhance the ability to reach markets and be vigorously involved in the market.

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The Farm Gate market opportunity seems to be the most predominant approach of marketing. In winter which is the predominant season in the study area it was 56,3% of the Maize we sold at the Farm Gate followed by 40,2% of Dry bean and 73,6% of Sweet potato. Hawkers were the next market channel with 43,2% of the Maize we sold at the Farm Gate followed by 30,8% of Dry bean and 71,2% of Sweet potato, respectively (Table 4). Marketing of produce for the majority of the farmers, particularly the food plot-holders, was a serious problem. It is clear from the findings that depending on hawkers may be due to the market generally not being well-organised, and poorly developed based on the availability of buyers. Backeberg, Bembridge, and Bennie, (1996) detect that 'an unfavourable economic location renders the profitable production of many products impossible. Development of a marketing system that will serve as a mechanism through which farmers can channel their produce. Similarly, an improvement in a marketing information system is vital.

The proposal by van Averbeke, M'marete, Igodan, and Belete, (1998) indicated that there is a general need for the identification of suitable crops that can be grown profitably, without being sensitive to market conditions and distance, is valid. The success of any business venture hinges on the efficient functioning of the marketing system.

Table 4 Market share of selected crops (maize, dry beans and sweet potatoes) produced in Irrigated Smallholder Agricultural Enterprises in Vhembe District of Limpopo Province.

Type of market	**Winter**						**Summer**					
	Maize		**Dry Beans**		**Sweet Potatoes**		**Maize**		**Dry Beans**		**Sweet Potatoes**	
	f	***%***	***f***	***%***	***f***	***%***	***f***	***%***	***f***	***%***	***f***	***%***
Farm gate	27,0	56,3	39,0	40,2	39,0	73,6	86,0	43,2	4,0	30,8	37,0	71,2
Fresh produce	2,0	4,2	3,0	3,1	2,0	3,8	13,0	6,5	2,0	15,4	0,0	0,0
Contracts	6,0	12,5	0,0	0,0	0,0	0,0	1,0	0,5	0,0	0,0	0,0	0,0
Hawkers	0,0	0,0	14,0	14,4	1,0	1,9	38,0	19,1	2,0	15,4	6,0	11,5
Export	0,0	0,0	25,0	25,8	0,0	0,0	26,0	13,1	3,0	23,1	0,0	0,0
Non-response	13,0	27,1	16,0	16,5	11,0	20,8	35,0	17,6	2,0	15,4	9,0	17,3
Total	**48,0**	**100,1**	**97,0**	**100,0**	**53,0**	**100,1**	**199,0**	**100,0**	**13,0**	**100,1**	**52,0**	**100,0**

3.6.Seasonal Variation in the Management & Division of Labour of ISAEs in the Production Of Selected Field Crops

Crops in this category include Maize, Dry beans and Sweet potatoes which are categorized as field crops. These crops are produced as cash crops for the farm gate market. Harvesting of these crops is very labour demanding. Mupaso, Nyamutowa, Masunda, Chipunze and Mugabe**,** **(**2014), confirms that the introduction of ISAEs contributed to employment creation for both the beneficiaries and non-beneficiaries as well. The production may also require high investments for inputs and protection.

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Table 5 Division of labour for selected crops (maize, dry beans and sweet potatoes) produced in Irrigated Smallholder Agricultural Enterprises in Vhembe District of Limpopo Province.

Division of labour	**Winter**		**Summer**	
	f	***%***	***f***	***%***
Exclusively men	2,0	0,7	0,0	0,0
Mainly men	6,0	2,0	2,0	0,7
Mainly women	113,0	38,4	147,0	50,0
Exclusively women	133,0	45,2	112,0	38,1
Men and women equally	8,0	2,7	9,0	3,1
None-response	8,0	2,7	24,0	8,2
Total	**270,0**	**91,7**	**294,0**	**100,1**

The investment in inputs and protection may guarantee minimum prices, which depend on the quality. This means considerable management skills are required to organize plant production, harvesting in time and examining every single plant at which point it should be taken care of or harvested. Most irrigated smallholder agricultural entrepreneurs at ISAE-s were based on observations provided by the research. The results of the study indicated that in both seasons, most irrigated smallholder agricultural entrepreneurs (45,2%) indicated that the production is managed exclusively by women, followed by 38,4% who said mainly women manage. Whereas, in the summer half of the irrigated smallholder agricultural entrepreneurs (50,0%) indicated that mainly women manage production, together with 38,1% who mentioned that the production is exclusively managed by women (Table 5). Contrary to the above, in most cases, females tend to be sidelined in terms of production field management due to cultural norms though they usually are the ones who provide most of the farm labour (Deribe, 2008). These results re-affirms that women make essential contributions to agriculture and rural agricultural enterprises. However, it should be noted that It is also alternative employment to females who remain at home while their husbands are looking for employment in cities and other groups who were previously employed.

3.7.Seasonal Economic Contribution of the three selected Field crops to the ISAEs and informal economy of the region

3.7.1. Production Indicators for Selected Field crops in Winter

The estimates of output and income levels for selected Field crops produced by ISAEs in the Madimbo Corridor and Mutale Upper Valley are shown in Table 6. For the three selected Field crops under investigation, Maize is the most important grain crop in South Africa, being both the major feed grain and the staple food for the majority of the South African population (DAFF, 2003). According to statistic SA, (2018/2019), the total production of maize in South Africa amounted to 10.51 million metric tons. Free State was the province with the highest production in all nine states with approximately 4 066 000 metric tons of the overall production. Limpopo province was having 200 000 metric tons and the lowest state was Western Cape producing 34 000 matric tones. In Table 6, the mean maize area irrigated was ± 0,75 ha. On average, irrigated smallholder agricultural entrepreneurs had a total production of 10 bags (80 kg).

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The Dry bean is at present regarded as one of the most important field crops in South Africa on account of its high protein content and dietary benefits. Among the annual leguminous food crops that are harvested for dry seethe, the dry bean is by far the most important (DAFF, 2010). The mean dry bean production area was 1,61 ha. In Table 6, most irrigated smallholder agricultural entrepreneurs had a total production of 15 bags (80kg). Sweet potatoes are cultivated throughout tropical and warm temperature regions wherever there is sufficient water to support their growth. The main producing regions are Northern Cape, Western Cape, Limpopo, Free State, Eastern Cape and Gauteng. Sweet potato is also the world's major food crop. In South Africa, sweet potato is mainly produced in Limpopo (Hoedspruit, Marble Hall, Burgersfort, Levubu), Mpumalanga (Nelspruit), KwaZulu-Natal and Western Cape provinces are the major production areas (DAFF, 2011). The mean sweet potatoes area irrigated was 0,53ha (Table 1). Mean total production of 100 crates (25 kg).

The causes of the low productivity of these field crops among other factors can be attributed to unproductive agronomic practices. Attention should be given to increasing the amount of land per irrigated smallholder entrepreneur if farming is to generate sufficient household income. However, raising the productivity of field crops could increase household income and food security significantly. This supports the conclusion of the research by Monde, Mtshali, Mnkeni, Chiduza, Modi, Brutsch, Dladla and Mthembu, (2005). that in both dryland and irrigated environments in the Peddie district, agriculture does contribute to the income of many households, but rarely constitutes a livelihood in its own right.

Table 6. Estimates of productivity and income levels for selected Field crops produced by ISAEs in the Madimbo Corridor and Mutale Upper Valley.

PRODUCTION INDICATORS	SELECTED AGRONOMIC CROPS		
	Maize	Dry Beans	Sweet Potatoes
[1]Estimated Mean Cultivated Area (ha)	0.75 Ha	1.61 Ha	0.53 Ha
[2]Estimated Mean Output (kg)	(10 bags X 80 kg) 8 00	(15 bags X 80Kg) 1 200	(100 Crates X 25Kg) 2 500
[3]Estimated Mean Income from Agronomic Crops (Rand)	350 Rand PER 80Kg R4.00 / Kg	600 Rand PER 80Kg 7.50 Rand / Kg	100 Rand PER 25Kg 4.00 Rand / Kg
[4]Estimated adjusted Income based on Mean output	R3 200	R9000 00	R10 000
[5]Estimated proportion of ISAEs cultivating the stated Agronomic Crop	0.66	0.09	0.02
[6]Estimated Total Area (ha) cultivated in the Vhembe District by ISAEs	37,940	692	5,180
[7]Adjusted Total Area (ha) cultivated with selected crops	25 040.4	62.28	103.6
[8]Estimated Total Output (kg) adjusted cultivated area in Vhembe	26 709.760	46 419. 875	488 679.245
[9]Informal Market Price	R4.00/kg	R7.50/kg	R4.00/kg
[10]Estimated Total Value earned by ISAEs in Vhembe District (Rands)	106 839 040.00	348 149.06	1 954 716. 98
[11]Market Price	R2.88/kg	R12/Kg	R6.72/kg
[12]Estimated Total Value earned by ISAEs in Vhembe using Market price (Rands)	R76 924 109	R1 856 795.03	R3 283 924.53

[1]Estimated Mean Cultivated Area (ha) = estimated from data analysis mean cultivated area
[2]Estimated Mean Output (kg) = Number of kg multiplied by the weight of kg

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[3]Estimated Mean Income from Agronomic Crops = informal market price
[4]Estimated Adjusted Income based on Mean Output = (2) X (3)
[5]Estimated proportion of ISAEs cultivating the crop out of total in Vhembe (ISAEs = 230 000)
[6]Estimated Total Area (ha) cultivated in the Vhembe District = estimated from crop suitability model
[7]Adjusted Total Area (ha) cultivated in the Vhembe District = Estimated to be the proportion (5) X Estimated area (ha) in Vhembe (6)
[8]Estimated Total Output (Kg) adjusted to cultivated area in Vhembe District = [(2) X (7)] / (1)
[9]Informal Market Price
[10]Estimated Total Value earned by ISAEs in Vhembe District (Rands) = (8) X (9) (Informal Market Price)
[11]Market Price
[12]Estimated Total Value earned by ISAEs in Vhembe District (Rand) = (8) X (11) (Market Price).

3.7.2. Production Indicators for Selected field crops in summer

The low yields realized by smallholders have been concrete evidence of poor farmer performance on smallholder irrigation schemes (Crosby et al., 2000). Agricultural production output is usually expressed in yield per hectare, in the ISAEs included in the study is generally not satisfactory. This is especially so with crops such as maize where productivity is below the expected average for the country. In this study, productivity was determined by estimated mean output in kg. This entails that a number of kgs multiplied the weight by which the product is mainly sold. In Table 6, the average of 0.75ha of maize, the mean output of farmers is 10 bags and maize on average is sold in 80 kg locally. Therefore, the total production means output of maize is 800kg which after conversion is 0.75t/ha (three-quarter-ton). The reason for the low kg of maize can be that most of the maize sold while still cob. This was confirmed by Van Averbeke (2008) who explained the relationship by pointing out that the monetary value of a green cob was about 5 times higher than a cob harvested for grain. He reported that at most, farmers at Dzindi sold 25% of their maize as green cobs.

Dry bean is cultivated at the estimated mean area of 1.61ha. The mean output of the farmer is 15 bags and Dry bean on average is sold in 80 kg locally. Therefore, the total production means output of maize is 1 200kg which after conversion is 0.75t/ha (three-quarter-ton). Whereas in sweet potatoes, the mean output of the farmer is 100 crates and sweet potatoes on average is sold in 25 kg locally. Therefore, the total production means output of sweet potatoes is 2 500kg which after conversion is 4.7t/ha. The productivity of irrigated smallholder agricultural entrepreneur's is one of the most important reasons for the failure of most production areas to achieve food security. Consideration should be given to increasing the amount of land per irrigated smallholder entrepreneur if farming is to generate sufficient household income. However, raising the productivity of field crops could increase household income significantly.

3.7.3. Seasonal Economic Indicators Comparisons for the contribution of the selected field crops through the informal and formal market in summer

According to Nesamvuni, Tshikolomo, Belete, and Motaung, 2014), the level of profitability of farming among rural households has a strong influence on farming income. Most maize farmers in the ISAEs may seem not to make a profit from maize production. The fact that maize productivity was low also contributed to many farmers experiencing income loss. In Table 7, the estimated total output (kg) adjusted in the cultivated area at Vhembe District maize

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production is 26 709 760 and the average price of 80kg of maize bags is R350.00. Therefore, the total mean output of maize grains is R4.00/kg. The estimated total value earned by ISAEs in Vhembe District (Rands) through the informal market is R106 839 040.00.

For Dry bean is 46 419. 875 and the average price of 80kg of Dry bean bags are R600.00. Therefore, the total mean output of dry bean grain is R7.50/kg. The estimated total value earned by ISAEs in Vhembe District (Rands) through the informal market is R348 149.06. While in sweet potatoes are 488 679.245 and the average price of 25 kg crate of sweet potatoes is R120.00. Therefore, the total mean output of sweet potatoes is R5.00/kg. The estimated total value earned by ISAEs in Vhembe District (Rands) through the informal market is R1 954 716. 98. Table 7, also estimate the formal market of the selected field crops. Estimated Total Output (Kg) adjusted to the cultivated area in Vhembe District in maize were multiplied by R2.88/kg as the price in the formal market.

The estimated total value earned by ISAEs in Vhembe District (Rands) through the informal market is R76 924 109. For Dry beans were multiplied by R12/kg as the price in the formal market. The estimated total value earned by ISAEs in Vhembe District (Rands) through the informal market is R1 856 795.03. Whereas Sweet potatoes were multiplied by R6.72/kg as the price in the formal market. The estimated total value earned by ISAEs in Vhembe District (Rands) through the informal market is R3 283 924.53. In a comparison of the two above, the ISAEs who rely on the informal market is making more profit than the formal market. The challenge may be the market is not reliable. In selling through the formal market, the market deducts 5% of commission while the market agent deducts 7.5% of sales on the gross value of the sold product. This doesn't include the transportation charges to the market.

Table 7. Estimates of productivity and income levels for selected Agronomic crops produced by ISAEs in the Madimbo Corridor and Mutale Upper Valley.

PRODUCTION INDICATORS	SELECTED AGRONOMIC CROPS		
	Maize	Dry Beans	Sweet Potatoes
[1]Estimated Mean Cultivated Area (ha)	0.75 Ha	1.61 Ha	0.53 Ha
[2]Estimated Mean Output (kg)	(10 bags X 80 kg) 8 00	(15 bags X 80Kg) 1 200	(100 Crates X 25Kg) 2 500
[3]Estimated Mean Income from Agronomic Crops (Rand)	350 Rand PER 80Kg R4.00 / Kg	600 Rand PER 80Kg 7.50 Rand / Kg	100 Rand PER 25Kg 4.00 Rand / Kg
[4]Estimated adjusted Income based on Mean output	R3 200	R9000 00	R10 000
[5]Estimated proportion of ISAEs cultivating the stated Agronomic Crop	0.66	0.09	0.02
[6]Estimated Total Area (ha) cultivated in the Vhembe District by ISAEs	37,940	692	5,180
[7]Adjusted Total Area (ha) cultivated with selected crops	25 040.4	62.28	103.6
[8]Estimated Total Output (kg) adjusted cultivated area in Vhembe	26 709.760	46 419. 875	488 679.245
[9]Informal Market Price	R4.00/kg	R7.50/kg	R4.00/kg

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[10]Estimated Total Value earned by ISAEs in Vhembe District (Rands)	106 839 040.00	348 149.06	1 954 716. 98
[11]Market Price	R2.88/kg	R12/Kg	R6.72/kg
[12]Estimated Total Value earned by ISAEs in Vhembe using Market price (Rands)	R76 924 109	R1 856 795.03	R3 283 924.53

[1]Estimated Mean Cultivated Area (ha) = estimated from data analysis mean cultivated area
[2]Estimated Mean Output (kg) = Number of kg multiplied by the weight of kg
[3]Estimated Mean Income from Agronomic Crops = informal market price
[4]Estimated Adjusted Income based on Mean Output = (2) X (3)
[5]Estimated proportion of ISAEs cultivating the crop out of total in Vhembe (ISAEs = 230 000)
[6]Estimated Total Area (ha) cultivated in the Vhembe District = estimated from crop suitability model
[7]Adjusted Total Area (ha) cultivated in the Vhembe District = Estimated to be the proportion (5) X Estimated area (ha) in Vhembe (6)
[8]Estimated Total Output (Kg) adjusted to cultivated area in Vhembe District = [(2) X (7)] / (1)
[9]Informal Market Price
[10]Estimated Total Value earned by ISAEs in Vhembe District (Rands) = (8) X (9) (Informal Market Price)
[11]Market Price
[12]Estimated Total Value earned by ISAEs in Vhembe District (Rand) = (8) X (11) (Market Price).

4. Conclusion

The consequences of the observed diversity in livelihoods through some improved livelihood outcomes, either directly in the form of food or income for irrigated smallholder agricultural entrepreneurs, should tailor the socio-economic profile. The purpose of examining productivity, profitability, and Perception for Sustainable crop production at Irrigated Smallholder Agricultural Enterprises in Vhembe District, was to provide an updated socio-economic profile and determine whether the ISAEs utilization add value to the irrigated smallholder agricultural entrepreneurs' household livelihoods. These provided an overview of the current living standard of the community that resides within Nwanedi (Madimbo corridor) irrigated smallholder farming area and Tshiombo (Upper Mutale Valley) irrigated smallholder farming area. This will allow to identifying the comparative advantages, the vulnerability and the welfare within these community's residential areas**.**

5. Recommendations

The study recommends that (a) the productivity, profitability, and Perception of crop production at Irrigated Smallholder Agricultural Enterprises guide the development of relevant livelihood and food security programs; (b) that Policies with Agriculture, Land Reform, Rural Development SMME and Environment, Forestry and Fisheries can be reviewed to support women and Youth Agricultural Business.

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