

Small-Scale Irrigation Farming System Situational Analysis in Namibia: Case Study from Ndonga Linena Green Scheme, Kavango West Region

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Abstract – The aim of this paper is to examine the perceptions of small-scale irrigation farmers (SSIFs) with regard to climate change and their adaptation strategies in terms of its effects. This study forms part of a broader regional project, namely the Southern Agricultural Africa Inter-Comparison and Improvement Project (SAAMIP) on integrated regional climate assessment. In analysing the SSIF farm situation, meta-analysis was the selected methodological application. Farm-level data was collected from the entire population of 30 SSIFs at the Ndonga Linena Irrigation Project in February 2014. The findings reveal the key challenges of the project to be the level of entrepreneurship and creativity, management practices (including irrigation management, marketing, financial management and risk management), sustainability practices, transportation, storage facilities, high input costs and low output prices. The study consequently suggests that diversification via horizontal and vertical “line extension” and integrated farming systems would be the most suitable means of mitigating climate-induced risks. In doing so, it is essential that government, nongovernmental organisations and training institutions support the SSIFs in adopting the suggested model in order to ensure profitability and sustainability.

Keywords – Small-Scale Irrigation Farmers, Situational Analysis, Diversification, Line Extension, Integrate Farming System and Sustainability.

I. INTRODUCTION

Sub-Saharan Africa (SSA) is the region that is most vulnerable to climate change, due to the incidence of extreme poverty, frequent natural disasters such as droughts and floods, and agricultural systems that are heavily dependent on rainfall [6]. SSA in particular is predicted to be vulnerable to climate change in the long term, and to suffer considerably from the negative effects of climate change. [2]. Namibia is believed to be among the countries that are most vulnerable to climate change in SSA, since it is a nation characterised by semi-arid to hyper-arid conditions and highly variable rainfall, despite small stretches of the country (about 8 %) being classified as semi-humid or sub-tropical [11]. Rainfall distribution across the country varies from an average of <25 mm per year in parts of the Namib Desert to 700 mm in parts of the Caprivi Strip to the northeast [9].

Although agriculture contributes only 5.9 % towards the national GDP, it is regarded as an important sector in the economy. Approximately 40 % of Namibia’s exports are based on agricultural commodities, while about 70 % of the population depends directly on subsistence agriculture for survival. Moreover, around 27 % of the country’s workforce and 58 % of the workforce in rural areas are employed in the agricultural sector [11].

In addition to climate change and variability challenges, a lack of supporting marketing infrastructure and related essential services has also contributed to local producers’ inability to identify market opportunities [11].

This study focuses mainly on the Okavango region, where some significant crop irrigation incentive projects are located. Small-scale irrigation farming systems in the area receive high-level government support in the form of a “Green Scheme”, as a means of promoting crop production for export in support of the economy [3]. In this region, pearl millet, maize, sorghum and cassava are among the dominant crops. Approximately 95 % of cultivated land is planted with millet, with only small patches of mostly clay soils are used for maize and sorghum production [9].

The Okavango region is characterised by a semi-arid climate receiving an average rainfall of 550 mm per annum (October to April). The natural vegetation consists of fairly tall woodlands and tree savannahs. The dominant soil types are Kalahari sands, which are nutrient-poor aerosols with low water retention [14]. The region is one of the most densely populated in Namibia, with a population of 202 694 [8].

II. STUDY METHODOLOGY

A. Study area

The main study area of the Ndonga Linena Green Scheme Project is located 80 km along the Rundu Katima Mulilo highway, at coordinates 17°57’20.41 S and 20°31’41.56 E, and at an elevation of 3 543 ft. The project involves 30 SSIFs, all of whom were included in the study. The soil type is mainly sandy soils with excellent drainage. The area has an average temperature of 22.4 degrees Celsius, with an average annual rainfall of 577 mm. Most rainfall occurs in the month of February, with an average of 147 mm [8].



Fig.1. Location of study area

Source: Google Earth (2014)

B. Methodology

A mega- (meta-) evaluation was carried out for purposes of the SSIF situational analysis.

Michael Scriven coined the term ‘meta-evaluation’ more than 40 years ago Scriven (1969). In simple terms, meta-evaluation means ‘evaluation of evaluations’ [18] and is concerned with bringing together the evidence from a range of studies and exploring the implications thereof for policy and practice. This allows for an overlap in purpose and methods with broad-based systematic mixed-methods reviews (‘synthesis studies’) and methods for testing the evidence for policy programmes [18].

The starting point for this study was that of meta-evaluation and a combination of evaluation science and methods of research synthesis. It involved the consideration of the methods for identifying relevant primary research studies, thus assessing quality, relevance and techniques able to bring about the interpretation of the empirical data collected and field-visit observations. The approaches taken were those of open discussion and communication with the audience for meta-evaluation of the target group. The methodology used can be described as follows:

International literature review: The existing academic literature on SSIFs in Namibia was reviewed in detail prior to the commencement of the study, so as to clarify the processes of meta-evaluation.

Roundtable discussion on methods: As the primary means of analysis for this study, discussions were held with the farmers to evaluate their experiences regarding irrigation farming management so as to examine the strengths and weaknesses of their farming methods. The outcomes of these discussions will also inform the industry and policymakers regarding irrigation farming.

Consultation with the industry: Primarily this study formed part of the broader SAAMIIP and consisted of an integrated regional assessment, combining climate, crop and economic modelling in order to examine climate variability and changes threatening food security in SSA. In order to assess the climate impact objectively, the process of holistic model development commenced with regional research teams (RRTs) working together with

stakeholders to define the outcomes to be evaluated and to then develop details of the specific agricultural systems to be quantified. Through this process of working with stakeholders, representative agricultural pathways (RAPs) were created to represent visions of the future trends in agricultural systems for the region, consistent with broader global societal and climate pathways. The RAPs were aimed at developing qualitative and quantitative storylines of future trends, and therefore the opinions of experts and others directly involved in small-scale irrigation farming were sought in order to assess in detail the strengths and weaknesses of their experiences, as well as the practical lessons learnt, and to collate examples of useful experiences to enable or assist policy frameworks.

Analysis and reporting: Using the findings from the literature review, as well as the roundtable discussions and primary research, a set of recommendations and guidelines on the stages and steps involved in conducting meta-evaluation was developed.

A total of 30 small-scale farmers and three knowledgeable individuals (regional researcher, government official, and irrigation project manager) participated in the study. The small-scale farmers possessed different levels of formal education, but had the same level of training in agriculture. All the farmers were involved in the Ndonga Linena Irrigation Project in the Okavango region of Namibia.

The study adopted the bottom-up approach as a means to gain insight from the farmers themselves based on a farm household survey. The primary farm-level data was collected by means of a semi-structured and self-administered questionnaire. Moreover, interviews were conducted with the aforementioned officials to gather information on key informative issues surrounding the livelihoods of small-scale farmers.

III. RESULTS AND DISCUSSION

A. Description of household characteristics

Table 1 presents a summary of the household characteristics, i.e. gender, age, educational level, family size and farming experience. As shown in Table 1, the

gender distribution consisted of 53 % male and 47 % female. The average age of the farmers was 30 years, with an average of 13 years of education (12 years of schooling plus one year of irrigation management training). The average family size was three members, while average farming experience was four years.

Table 1: Household demographics

Gender	Male	16
	Female	14
Average age		30
Average educational level		13
Average household size		3
Average farming experience		4

B. Farm situational analysis

Over the past five years, the Namibian government has spent N\$40 million on infrastructure development and capacity building for young farmers in the Okavango region, with the aim of creating jobs, driving economic growth and ensuring food security for the nation [12].

Interviews with government officials and researchers working in the study area revealed that ‘youth entrepreneurship’ is critical for the practical application of enterprise qualities such as initiative, innovation, creativity and risk-taking in the work environment (through either self-employment or employment in small start-up firms), using the appropriate skills necessary for the success of the project. An interview [12] with the government official in charge of the Green Scheme revealed that the importance of promoting this small-scale irrigation project lies in the following points: creating employment opportunities, integrating the alienated and marginalised youth into the economic mainstream; addressing some of the socio-psychological problems and delinquency arising from joblessness; promoting innovation and resilience amongst the youth; creating more direct, indirect and induced job opportunities; and promoting multiplier effects to other sectors.

B.1. Farmers’ future planning

Figure 2 shows the future planning of farmers within their plots of land (with 1 representing the top priority and 4 the bottom priority).

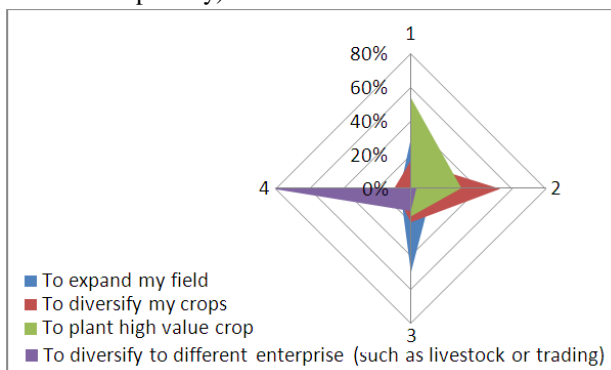


Fig.2. Future planning strategies (with 1 being the top priority and 4 the bottom priority)

As shown in the figure, approximately 50 % of the farmers identified a shift to high-value crops as being their

main vision for the future, while 50 % identified crop diversification as their second-highest priority. Less than 50 % chose the expansion of their field as third on their list of priorities, while more than 80 % of farmers listed the establishment of a mixed farming system of livestock and crops as last on their list of priorities.

To summarise, 53 % of farmers identified high-value crops as being their top priority, which implies heavy future investment in such crops, taking into account the existing limited farm size, as well as the lack of interest in livestock farming.

B.2. Farm system practices

An interview [16] was conducted with the general manager of Shikunino Trading Enterprises, which is a large-scale irrigation company acting as service provider to the SSIFs. Shikunino Trading Enterprises markets and supplies the farmers’ produce to the local market, as well as markets in the Cape and Angola. Fresh produce hubs in the vicinity of the town of Rundu have become an opportunistic market for these farmers and have the potential to improve their marketing system. However, the general manager [16] emphasised that the project is faced with a number of production challenges that are hindering its efficient operation:

- Inputs are not only extremely costly, but they are also often unavailable locally, meaning that they have to be imported, which results in a delay in input supplies.
- The sharing of farm implements, machinery and equipment amongst commercial and SSIFs has a negative impact on production.
- The lack of a marketing plan for the SSIFs results in the oversupply of homogenous produce in the local market.
- Dissatisfaction with the grain prices fixed by the Namibia Agronomic Board on the basis of the South African Futures Exchange (SAFEX) has led to the SSIFs selling their produce outside the terms of their agreement with the service provider (i.e. the service provider’s agreement to supply the required support and input services to the SSIFs, in return for the SSIFs selling their produce exclusively to the service provider). By choosing to sell their produce on their own instead of supplying it to the service provider, the farmers default on the settlement of their debt to the service provider and are unable to secure continuity of input supply from the service provider. Furthermore, it creates poor relations and a sense of mistrust between the service provider and the SSIFs, while the lack of an integrated/joint marketing approach within the projects leads to the service provider and SSIFs competing for the same market.
- Distance to the market is one of the major causes of high production costs for the SSIFs. With reliable markets being situated far from the location of the project, transportation costs are extremely high.
- Inadequate post-harvest storage, packing and handling facilities pose a major challenge.
- A combined prepaid water/electricity system for both the service provider and the SSIFs at the pump stations has resulted in billing conflicts.

- Unfavourable environmental and climate changes continue to hamper production in several ways, with frequent high temperatures caused by relatively low

rainfall, prevailing floods in the region, and low levels of water from the source (Okavango River) due to the low rainfall.



Fig.3. Farm operations affected by climate change

Source: Montle (2014)

C. Economic, social and ecological sustainability factors

This section presents an evaluative summary of the economic and social sustainability factors affecting farmers in the study area, as well as the sustainability practices involved in their farming operations (from both an ecological and profitability perspective), the extension flexibility of their production line (including their entrepreneurship and creativity levels), and the risk management aspects involved.

C.1. Economic and social sustainability factors

[4] Table 2 presents a summary of the operationalized components of the economic and social sustainability factors, organised under nine classifications: productivity, profitability, stability, diversity, flexibility, time dispersion, sustainability, complementary compatibility, and environmental compatibility. This would imply that the system is socially acceptable in terms of income distribution and ownership; however, due to the scope and data limitations of this study, only four key aspects affecting the small-scale farmers of Ndonga Linena were evaluated (i.e. productivity, profitability, diversity, and production line flexibility).

Table 2: Economic and social sustainability factors

Property	Indicator
I. Productivity	Yield per ha/land plot
II. Profitability	In financial terms or measured subjectively as net benefits or gross margin
III. Diversity	
1. Number of activities	1. Number of activities in system
2. Number of products	2. Number of products of system
3. Number of income sources	3. Income diversity ratio
IV. Production Line Flexibility	Number of first, second... degree uses to which products can be put (sold, consumed, processed)

C.2. Sustainable productivity

Over the past five years, the SSIFs of Ndonga Linena have produced on average between 11 and 13 tons per hectare. In comparison, during the same period, large-scale commercial farmers in South Africa produced on average between 10 and 30 % more per hectare, which shows that it is not possible for SSIFs to achieve commercial yields in the early stages of the project. In terms of the sustainability of the Green Scheme project, a researcher [22] engaged in the Future Okavango project for the past five years reported that most of the activities of the project would be unsustainable and not economically viable without government support.

The project relies on synthetic fertilisers, which are applied throughout the entire production cycle to stimulate crop growth and yields with the aim of maximising profits (see Figure 4). Such fertilisers have a negative effect on soil health and water, since natural soil fertility deteriorates over time as the soil becomes reliant on the fertilisers, and a process of eutrophication occurs within water sources. Moreover, the chemical pesticides and herbicides that are used for control purposes pose a major environmental risk, destroying soil micro-organisms and affecting natural living organisms into the future.



Fig.4. Chemical fertilisers used in the project

Source: Montle (2014)

C.3. Sustainable profitability

As indicated in Table 5, the international market creates pressure on both the supply and demand side. Figures 10 and 11 also show that farmers are experiencing a cost-price squeeze caused by high input costs and low output prices. Findings from SAAMIIP [15] indicate that small-scale farmers in Namibia are challenged by factors such as poor production marketing, financial risks and low managerial skills (in terms of production, marketing and finance management), thus limiting capacity growth and the profitability of enterprises. Limited markets, together with time and distance issues, have seen farmers competing for the same market in the midst of inadequate market infrastructure and services. Farmers are also operating in an unfavourable policy environment in which they lack guidance and support from the agricultural sector.

C.4. Crop rotation and level of diversification

In terms of crop rotation and level of diversification, farmers should ideally plant a summer crop (maize) followed by a winter crop (wheat), with a perennial crop (lucerne) for purposes of soil nitrogen fixation. However, with this practice being very limited within the study area, farmers are exposed to both production/business risks and marketing risks [15].

An interview [12] revealed that small-scale farmers are aware of climate change and are practising certain sustainability strategies such as early planting, crop diversification, use of hybrids seeds and moisture conservation. The government has also engaged in trials to avail land for purposes of project expansion, as a means to benefit the project when it comes to maximisation of profits and market diversification [12]. However, as indicated in Table 3, 30 % of farmers farm only with mono crops, while only 70 % practice some level of crop diversification. Table 3 furthermore shows that of the total number of farmers in the study area, 21 apply diversification strategies to different crop alternatives. Of those, 38 % extend their level of diversification to only two crops, whereas 24 % diversify to three crops, 19 % to four crops, and 14 % to more than four crops. This shows that farmers are vulnerable to both production and marketing risks.

Table 3: Level of enterprise diversification

Twenty-one farmers (out of 30) who diversify their enterprises	
38 %	Diversify to two crops
24 %	Diversify to three crops
19 %	Diversify to four crops
14 %	Diversify to more than four crops

C.5. Production line flexibility

The small-scale farmers involved in the study have been operating for some time, yet their capital has not yet grown as required. A crucial question is why these small enterprises remain small. It could be that they do not have the potential to grow their return, due to poor management or lack of growth potential within the market. Another reason may be market inefficiency – for example, poor information leading to limited growth capacity. Limited access to financing is a major challenge and a strong reason for government intervention and support, but this needs to be proven on a case by-case basis. Simple promotion of SMEs through subsidies to enterprises with employment below a certain level would be a poor target, since government would simply end up supporting numerous stagnant SMEs, creating a disincentive to grow and thus risk losing access to the subsidy [20].

As indicated during an interview [16], farmers are facing the challenge of increasing their productivity while stuck in a bottleneck created by the following issues:

- Growing season: Despite having received irrigation training, the farmers lack crop and commodity-based diversification. Furthermore, farmers make little effort to understand the market requirements, only planting and depending on a few commodities with a secured market. As a result, farmers produce homogenous products and compete with one another for a limited market with the same production line.
- Production technology: Government encourages land consolidation and crop intensification for small-scale farmers as a means of enabling them to bring together or combine their efforts, both physically and materially. In addition, government has established a mechanisation strategy that allows farmers to use machinery to improve their crop yields; however, the farmers are

generally unwilling to combine their fields and work together to achieve the advantage of economies of scale in the area.

- **Post-harvest handling:** Weight losses typically range from 5 to 40 % of production, averaging approximately 13.5 % [21]. For Southern Africa the value of this weight loss is estimated to be about 1.6 billion US dollars per annum, and possibly about four billion US dollars for SSA as a whole. This exceeds the value of the total food aid received by SSA in the decade 1998–2008 [20]. Post-harvest grain losses result from both the scattering of grain due to poor post-harvest handling (harvesting, threshing and transport) and bio-deterioration brought about by pest organisms including insects, moulds and fungi, rodents, and sometimes birds [1] [7] [10].

The effects of bio-deterioration are aggravated by mechanical damage during handling, as broken grain is much more susceptible to quality decline through pest attacks. Furthermore, inadequate storage protection allows for the entry of water and facilitates easy access by insects and rodents, while large-scale bag storage allows for a chemical reaction leading to grain discoloration ('stack burn'). Grain weight loss is easily understood as a loss of food [21].

The farmers also depend on government for the services of a combined harvester, and delayed delivery in most cases results in heavy losses while the crops are left in the fields.

The challenges reported above are not exclusive to SSIFs in the Okavango; farmers throughout Southern Africa suffer the same fate.

Differentiation: Creativity in terms of differentiation, including products and packaging, is mostly lacking among these small-scale farmers. As indicated in Figure 8, lack of farm knowledge is the greatest challenge hampering farmers' creativity.

- **Marketing creativity:** An interview [12] revealed that thus far, marketing and sourcing of the input materials has been the responsibility of government, and the SSIFs have never been concerned with marketing their produce or even exploiting the services provided by the government. Still, the issue of market creativity is lagging and farmers therefore require a great deal of support in terms of capacity building and improving their marketing skills in view of marketing their produce collectively. Connecting to the right channels of distribution, as well as transport and logistics systems, remains challenging for these farmers.

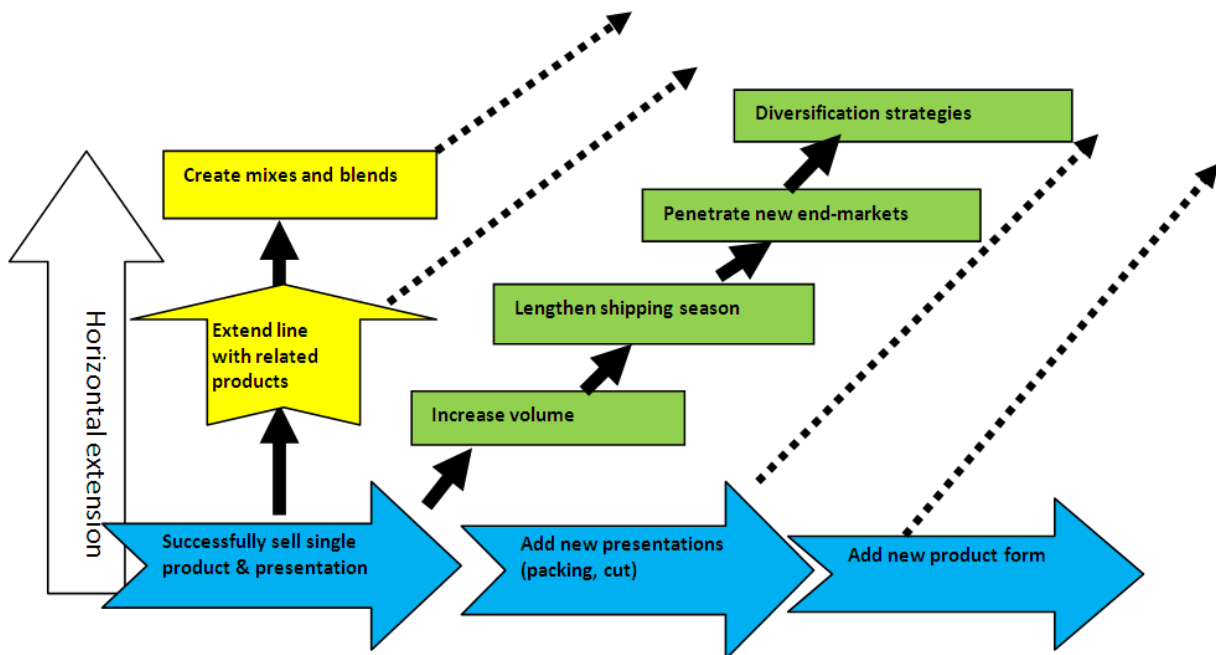


Figure 5: Combining the line extension strategy with a diversification strategy

In the fresh produce industry, as a common strategy, it is crucial to specialise in a given category and then diversify via horizontal and vertical “line extension”, as shown in Figure 5 above. Where farmers are required to adopt this strategy, however, it is important that government and training institutions support the farmers to ensure that the model can be adopted successfully.

The above model will assist farmers in taking advantage of the following:

- Lower production costs
- A shift to new crop varieties

- An integrated production and marketing plan with the potential to avoid marketing and production risks
- The generating of the required volumes and consistency of supply

C.6. Ecological sustainability

Table 4 below depicts the checklist for "operationalising" ecological sustainability in agriculture from a natural science point of view [4], which on its own is not sufficient for sustainability research, but rather provides guidelines for best practice.

Table 4: Sustainable use of natural resources

Sustainable use of natural resources

- Energy in agriculture; renewal of energy sources
- Soil and the maintenance of soil fertility
- Efficient water use, production maintenance of water availability, and maintenance of water quality
- Biodiversity of production organisms; maintenance of populations, i.e. species; maintenance of genetic diversity

C.7. Soil and fertility management

There are various challenges hindering sustainable soil and land resources, such as nutrient depletion and low organic matter content of soil due to unsuitable farming practices such as mono-cropping and low levels of crop rotation and crop diversification [2].

The high cost of imported fertilisers is a problem, resulting in the underuse thereof. However, even organic fertiliser such as manure is not commonly used or readily available in the study area. There is also limited access to improved seed varieties and agrochemicals to combat pests and diseases, coupled with the farmers' limited knowledge of fertiliser input [17].

The small-scale farmers of Ndonga Linena practice limited crop rotation and crop combination, and as a result their main crops (maize and wheat) have the same nutrient requirements, thus affecting soil balance in the same way. These crops are heavy feeders that quickly deplete the soil's nitrogen and phosphorus levels, later resulting in soil that is not balanced. The continuous growing of the same crops from the same botanical family on the same piece of land, without good rotation, increases the incidence of diseases and pests.



Fig.6. Soil nutrient depletion
 Source: Teweldemedhin (2012)

C.8. Water usage efficiency

Water use has been shown to be unsustainable in that farmers do not understand, in a practical sense, how much water should be used for irrigation, and the frequency thereof, per day. At times the land is irrigated continuously for long stretches of time, past the point of saturation, thus wasting a great deal of water. Moreover, the project lies directly on the banks of the Okavango River, which is the source of water for irrigation, and the chemicals from the project that flow and dissolve into the river degrade the

quality of the water and pose a threat to human and marine life (environmental risk). The project's reliance on the river for irrigation remains in doubt due to the prevailing climate change conditions and the fact that the Okavango Delta in Botswana, which is the main aquifer filling the Okavango River, has been declared a world heritage site. In view of the threat to the water supply for the Green Scheme project along the Okavango River, it can be concluded that the project compromises sustainable development over economic development.



Fig.7. Project irrigation operations

Source: Teweldemedhin (2012)

C.9. Tillage operations

Figure 8 below shows the intensive practice of tillage operation, as observed during data collection. The effect of land clearance, followed by mechanised farming and industrial plantation, resulted very rapidly in erosion problems, which were countered by installing access

tracks along contour lines, establishing grass-covered ridges, and alternating rows of different ages and ground-covering capacity loss. Such continuous working of the soil with heavy implements serves to loosen the soil (destroy soil productivity), resulting in land degradation.



Fig.8. Heavy tillage operations

Source: Montle (2014)

This study revealed that the new emerging commercial farmers require considerable technical, managerial and financial support. In the current cost-price squeeze environment, the potential success of the project becomes more challenging, hence the need to increase the level of production and management proficiency amongst potential new farmers through training and skills development.

D. Perceived Challenges In Terms Of Input And Output Prices, As Well As Services

D.1. Ranking of farmer-perceived challenges

High input costs are perceived as the most significant challenge for small-scale farmers in the study area (see Table 6). In fact, high input costs are a major challenge for farmers in general in Namibia [13]. Commercial farmers in the country mostly import their input materials from the Republic of South Africa, and with the strong rand leading to high costs for production and transportation from South Africa to Namibia, the accessibility, availability and affordability of input materials remain extremely challenging to small-scale farmers [13]. In addition, factors such as international commodity prices have contributed to the difficulties facing farmers in Namibia. Some of the factors leading to high food prices are summarised in Table 5 below [19].

Table 5: Summary of reasons for high food prices

Demand factors	Supply factors
Strong growth in demand based on:	Slowing growth in agricultural production
• Increased population	Escalating crude oil price/higher energy prices
• Rapid economic growth	Exporter policies
• Rising per capita meat consumption	High input costs in general
	Climate change: adverse weather

Declining demand for stocks of food commodities	Reduced agricultural land
Dollar devaluation	
Large foreign exchange reserves	
Rising farm production costs	
Aggressive purchases by importers	
Importer policies	
Ethanol promotion	

Source: [19]

Crop farmers moreover face the problem of economies of scale in competing with external producers.

In terms of output price, 13 % of respondents ranked it first, 50 % as second, 23 % as third and 13 % as fourth on the list of challenges. The first two rankings combined gives 63 % of farmers most dissatisfied in terms of their produce, since they have so few marketing options in the Okavango region and can supply only to the designated service provider. The farmers do not have access to a closer market at which to sell their produce. Moreover, they produce similar or homogenous produce, and their timing of production also coincides. To aggravate matters further, their input costs are very high and their resulting profit margin very small.

Table 6 and Figure 8 show that 87 % of farmers ranked high input costs as the top challenge, while lack of farming knowledge was ranked by 47 % as third on the list and by 43 % as last on the list of greatest challenges. As the farmers had been receiving irrigation management training for one year, along with other frequent training by various agencies, knowledge was identified as a minor challenge.

Government support was expected to be named as the least challenging aspect, as the government provides capacity and infrastructure to the project on site. However, it is surprising to note that 27 % ranked this aspect second and 30 % ranked it third on the list of challenges. This

could be due to the farmers expecting continuous support in terms of assistance regarding marketing risks, including input supply and the provision of a profitable marketing channel.

Table 6: Rating of challenges experienced on Ndonga Linena Farm

Challenges rated 1, 2, 3 or 4 (1 being most challenging and 4 least challenging)				
Descriptions	1	2	3	4
Lack of farming knowledge	0 %	10%	47%	43%
High input costs	87 %	13%	0%	0%
Low output prices	13 %	50%	23%	13%
Lack of government support	0 %	27%	30%	43%

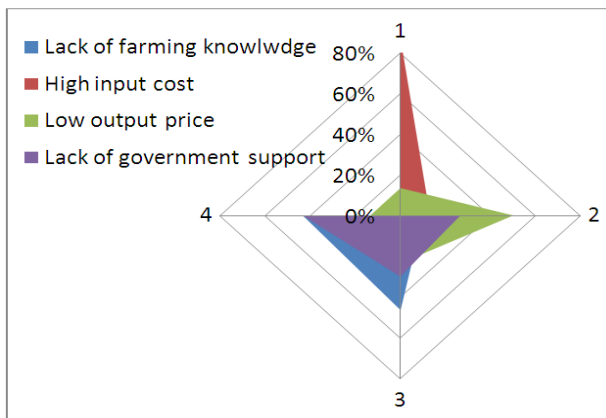


Fig.9. Major farm challenges

D.2. Perceived challenges in terms of input costs and output prices

Figures 10 and 11 present the ranking for input costs and output prices in the study area. With regard to the price of production inputs, 73 % of respondents ranked the price as very high, 3 % as high, 17 % as fair, and 7 % as low.

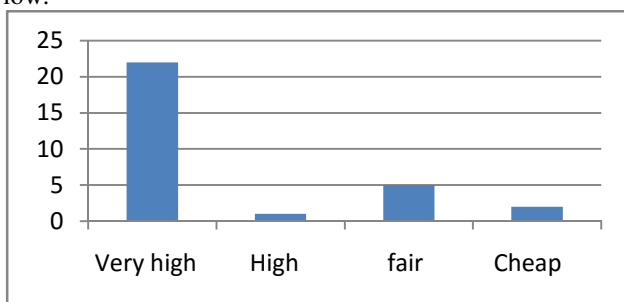


Fig.10. Price of inputs

With regard to the price of the respondents' products compared to their expenditure, 77 % indicated their product price as being much less than expenditure, 17 % as being fair, 6 % as being high, and 0 % as being very high in comparison. This clearly indicates that the limited access to alternative markets, lack of storage facilities, homogeneous products that are being harvested within the same timeframe, and limited diversification strategies are leading to a sense of dissatisfaction with output prices (see Figure 11).

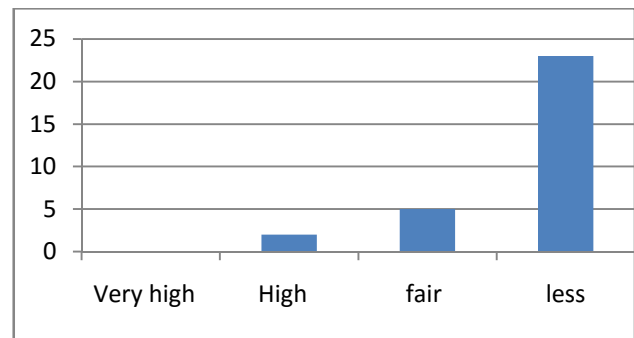


Fig.11. Output price

D.3. Priority area solutions for SSIFs

The Green Scheme project faces numerous challenges [13], including inadequate land expansion and frequent malfunctioning of the irrigation systems and implements due to long-term use, which affects production negatively. The farmers' lack of collateral would make it difficult for them to continue farming without government assistance upon the expiry of the five-year contract. The cost of electricity for pumping water is extremely high, and farmers often struggle to simply break even.

Table 7 show the farmers' suggested solutions to their problems, ranked from one as the top priority to five as the bottom priority within their farming system. Farm management skills were identified as a top priority by 40 % of respondents and as the bottom priority by 30 % of respondents, implying that the majority of the farmers are in need of the skills required to improve their general farming operations, including irrigation, soil, crop, marketing and financial management skills.

Financial assistance was ranked as first priority by 27 % and as second priority by 33 % of respondents, which combined constitutes 60 % of farmers requiring financial assistance. This is an obvious conclusion, as small-scale farmers lack the collateral necessary to access finances for their operations, thus making them vulnerable to production and marketing risks.

Transportation and market facilities were ranked by 43 % of respondents as fourth and by 27 % of respondents as fifth on the list of priorities within their farming system. Since the relevant service provider is responsible for their marketing activities, this aspect is not an issue at present (see Table 7).

Table 7: Ranking of priority areas in addressing constraints (1 being the top priority and 5 the bottom priority)

Description	1	2	3	4	5
Farming skills	40 %	7 %	17 %	7 %	30 %
Financial assistance	27 %	33 %	23 %	10 %	7 %
Effective transportation	0 %	17 %	13 %	43 %	27 %
Adequate market facilities	0 %	20 %	23 %	30 %	27 %
Sufficient input materials	33 %	23 %	23 %	10 %	10 %

A similar study conducted in Southern Africa [5] found that enhanced access to credit, adequate information on climate and agronomy, as well as access to input and output markets can significantly increase the level of farmers' adaptation to climate change.

D.4. Support services provision

Table 8 shows the farmers' ranking of basic service provision (with 1 being excellent and 4 being poor). With the exception of postal services, ranked as excellent by 87 % of respondents, the respondents revealed a general sense

of dissatisfaction with service provision in the study area. For example, healthcare services were ranked by 47 % of respondents as being very poor, which might pose a major challenge in terms of productivity.

D.5. Farmer support programme service provision

Table 9 depicts the ranking of farmer support programmes in the study area, with 93 % of respondents indicating that they had received training related to their farming system and 7 % indicating that they had received no training at all.

Table 8: Ranking of service provision within the study area (1 being excellent and 4 being poor)

	1	2	3	4
Schooling	10 %	17 %	60 %	13 %
Postal services	87 %	10 %	3 %	0 %
Water supply	10 %	27 %	27 %	37 %
Electricity supply	13 %	23 %	43 %	20 %
Road conditions	3 %	17 %	63 %	17 %
Healthcare	7 %	10 %	37 %	47 %
Public transportation	7 %	23 %	57 %	13 %

With regard to extension services, 30 % of respondents indicated/affirmed that they had access to extension services, whereas 70 % claimed to have no access to such services in the area. This implies that there is dissatisfaction amongst the farmers regarding extension services in the study area. With regard to extension services related to climate change, 77 % respondents indicated that they had received no advice on climate changing and variability, which is critical for future success. This implies that government and the higher education sector must ensure the training of personnel who are equipped to successfully share the necessary knowledge of climate change with the farmers.

Table 9: Farmer support programme

	YES	NO
Training related to farming system	28 (93 %)	2 (7 %)
General extension services	9 (30 %)	21 (70 %)
Extension advice on climate	3 (10 %)	23 (77 %)

D.6. Marketing, affiliation, credit access and transport

Table 10 shows that with regard to market and credit access, 73 % of respondents confirmed the availability of market facilities in the vicinity through the service provider, namely Fresh Produce Business Hub (FPBH), in Rundu, as well as the Namibia Agronomic Board (NAB), while 27 % of respondents indicated that they had no

access to the nearest available market. In addition, 63 % of respondents confirmed their affiliation with other organisations such as supermarkets, while 37 % indicated no affiliation with any other organisation besides NAB and FPBH.

Table 10: Market and credit access

	YES	NO
Availability of accessible market	22 (73 %)	8 (27 %)
Advance marketing plan	28 (93 %)	2 (7 %)
Affiliation with other organisations	19 (63 %)	11 (37 %)
Transportation problems	24 (80 %)	6 (20 %)
Access to credit	30 (100 %)	0

IV. CONCLUSION

The meta-analysis derived from information provided by key individuals at different levels revealed that lack of entrepreneurship and creativity, poor management practices (including irrigation, marketing, financial and risk management), lack of sustainability practices, poor transportation and storage facilities, as well as high input costs and low output prices are the major challenges faced by the project. However, this paper highlights the farmers' perceptions and priorities in terms of solutions to their problems, with farming skills and financial assistance at the forefront. Moreover, farmers identified their future

planning strategies as being the planting of high-value crops along with crop diversification, with no apparent interest in switching to livestock farming, thus implying that due to the structured farming system supported by government, farmers have limited opportunities to expand their farm size in view of exploring different enterprises. The study further found some degree of dissatisfaction among the farmers with regard to poor extension services in the area, with the consequent negative effect on production, as well as poor access to information on critical issues like climate change.

The study therefore suggests that diversification via horizontal and vertical “line extension” is necessary as a model to be adopted. However, in doing so, it is important that government, nongovernmental organisations and training institutions support the adoption of such a model so as to ensure that farmers can be profitable. Furthermore, the government and higher education sector must provide training to equip personnel with the necessary knowledge of climate change, entrepreneurship and sustainable agriculture, so that they can deliver the message to the farmers successfully. In addition, it is recommended that government avails extension services to the farmers in the form of capacity building and advice on critical issues such as marketing, creativity and participation, as well as production techniques, which will allow the farmers to be independent. Farmers should be well trained when it comes to post-harvest handling, product differentiation and integration, with promotion through the Agro-Marketing Trade Agency (AMTA). Since the Green Scheme project is a major government investment, government should improve the provision of basic services within the study area in view of improving farmers’ productivity, road conditions and electricity supply as amongst the most services in society.

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