

## **Economic Assessment of Solar Milling Plants as an Investment Tool: A Case of Katete District-Zambia**

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### **Abstract**

*The purpose of this study was to assess the economic impact of the solar milling plants to the local people in Katete District, Zambia. The specific objectives were to assess the performance of the solar milling plants, the effect of solar milling plants on mealie meal prices on the local market, the effect of solar milling plants on job creation in the district, and to find out challenges that co-operators are facing in managing the solar milling plants in the district for economic development, suggesting measures to be put in place to see to it that the program was sustainable. The research employed a qualitative research design, and extensive literature reviews were conducted in order to have a broader understanding of the research. The data was collected using the structured questionnaires and interview guide. The main findings of the research were that the hypothesis was rejected because there were no immediate economic benefits of the solar milling plants to the local people of Katete District. Following the results of the research, the solar milling plants were underperforming and underutilized in the district. Solar milling plants had no effect on the price of mealie meals in the district. Solar milling plants had a 40% effect on job creation in the district, and the study concluded that there were no immediate economic benefits brought about by solar milling plants in the district at the time of the study.*

**Keywords:** *Economic growth, Investment, Solar Milling Plants.*

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### **Introduction**

Solar milling plants are a Presidential Milling Plant Initiative that came about when his Excellency the Republican President of Zambia Mr. Edgar Chagwa Lungu, visited China in March 2015. The Solar-powered milling plants were procured under a loan from the China Development Bank, and in total, about 2,000 plants were to be installed in twenty-five (25) districts of the ten (10) provinces of Zambia that had the most potential for maize production. The Solar mill works directly through sun radiation, without batteries. The milling plants, which were costing US\$70,000 per unit, were under the management of the Zambia Co-operative Federation (ZCF) (www.xinhuanet.com/english/2019) [1].

These solar plants were handed over to Zambia Cooperative Federation (ZCF) so that co-operatives can access them through this federation. Therefore, the ownership of the solar mills was through the co-operatives, Government gave the solar power hammered mills to co-operatives, and co-operatives were running and managing them. In addition, any person was at liberty to take their produce for grinding at the plant. The solar milling plants project or initiative was a new project in Zambia, and it is being implemented for the very first time.

The program seeks to support the industrialisation of rural areas using the agriculture produce processing activities as part of a ZCF's five-year strategic plan to establish the industrial clusters that the government

wanted to achieve, as stated by one researcher [2]. The ZCF would support the mini-milling plants by buying 2 million tonnes of maize per year to place on the market and contribute with the reduction of mealie meal prices and decongest the Food Reserve Agency (FRA), whose reserves demanded high funds from the treasury.

The main objectives of the milling plants were expected to create about 3,000 jobs for local people. The consumers were assured that the cost of mealie-meal produced by solar plants would be affordable and sustainable. Apart from milling maize for sell, the plant also milled maize for other people as well; sell bran, a by-product in the milling process that would be sold to farmers and local people who would use it as feedstock for their animals. Other activities that the solar milling plant project would do apart from the primary milling of maize were to supply electricity to at least 25 surrounding houses, supply clean water to the community, irrigation of gardens and field crops, welding, fish ponds, poultry, and pig enterprises.

Katete district, in particular, applied for 52 solar plants, and only 40 were approved. Out of 40 solar plants, only 23 were in operational, while 17 were waiting for the installation to be completed. This meant that 23 co-operatives in the Katete district were running these 23 solar milling plants. These solar milling plants were locally known as “Chelse” by the local people in the district because of their colour of blue.

This research attempted to investigate the effectiveness of these solar milling plants in creating jobs for the local people. The hypothesis that had been taken to fulfill the work was that the solar milling plants have an economic impact on the local people of the Katete district.

## **Problem Statement**

The solar milling plants were procured by the government with the purpose of creating jobs to the local people, reducing the price of mealie meals on the local market, and also to increase entrepreneurial businesses to the co-operatives.

Some of these solar milling plants in Katete seem not to be working to their full production capacity, and they are not fully utilized such that there was very little that the local residents were seeing in terms of contribution of the milling plants in terms of job creation, reducing the price of mealie-meal on the local market and increasing businesses for co-operatives. The benefits of the milling plants had not yet been felt by the local people in the district.

Some of these plants seemed to be “white elephants”, and even those that were already operating may turn to be “white elephants” in the near future if they were left to operate the way they operate. The information gathered from respondents was that the milling plants were on a lease arrangement for 15 years. Zambia Cooperative Federation (ZCF) proposed that the co-operatives running and managing the solar milling plants should be paying K1, 700.00 per month to ZCF for 15 years, which is roughly K306, 000.00 by the end of 15 years period per co-operative. With the way the co-operatives were being run and managed at the time, it seemed paying back the loan by co-operatives wouldn't be feasible and attainable. The solar milling plants were put in place to bring an economic impact to the local people by creating jobs, reducing mealie-meal prices on the local market, and increase other entrepreneurial activities, but the objective seems very far from being realized in the Katete district. In short, the solar milling plants seemed not to have yet achieved the purpose they were intended to, especially for the Katete district in particular.

The significance of the research project was that the research would assess the performance of the solar milling plants in the district. The outcomes of the research would help all the stakeholders know the status quo of the plants. The research would also bring out the challenges the co-operatives were facing running the solar milling plants and suggest ways or recommendations in which the challenges could be addressed so that the milling plants could bring economic impact to the local people

through job creation, supplying affordable or relatively cheaper mealie-meal on the market and increasing entrepreneurial businesses for the co-operatives. The research project was also significant in the sense that it would help the initiators of the project, which was a government, policymakers, Zambia co-operative Federation (ZCF) know the status quo of these milling plants in Katete, and thereby maybe implement some of the suggestions that would come out of the research and also probably take corrective measures where needed for the betterment of the local people, and a district as a whole.

### **Overall Objective**

The research project aims to assist the government to assess the economic impact of the new solar milling plants to the local people in the Katete district. Specific Objectives.

The specific objectives of this study included the following objectives;

1. To assess the performance of the solar-powered milling plants in the Katete district.
2. To assess the effect of solar milling plants on job creation in the district.
3. To assess the effect of solar milling plants on mealie meal prices on the local market.
4. To find out the benefits and challenges that the co-operatives running these solar milling plants are facing and put-up suggestions.
5. To develop recommendations regarding the solar milling plants in the district.

### **Research Hypothesis**

**H<sub>0</sub>:** The solar milling plants have brought an economic impact to the local people in the Katete district.

**H<sub>A</sub>:** The solar milling plants have not brought an economic impact to the local people in the Katete district.

### **Rationale/significance**

The solar milling plants were a good project which was expected to bring benefits. The machines have 60 solar panels, and if fully utilized, it had the capacity to produce 40 X 25kg

of mealie-meal per day, meaning that in a week 280 X 25kg and in a month 1120 X 25kg of mealie-meal which can be supplied on the market at affordable consumer prices. In a year, the machine, therefore, could produce 13440 X 25kg of mealie-meal, which could be sold at maybe K60.00 instead of K85.00 market price of mealie-meal in the district, the co-operatives could have K806, 400.00 per year. In addition to that, the production flow of one 50kg bag of maize produced 25kg breakfast meal, 18kg roller meal, and 7kg maize bran. The above calculations show that the milling plants were a very good and profitable project.

Money had been invested in the solar-powered milling plants, and it was expected that the milling plants could prove to the Zambian people why it was important to invest in this project by bringing positive results or benefits to the people. Where there was an investment, there should be the recovery of investment and profits or positive impact of the investment. Therefore, it was of paramount importance from this literature review to carry out this research to investigate the economic assessment of Solar Milling Plants as an Investment Tool: A Case of Katete District-Zambia.

### **Literature Review**

A study [3] stated that Chinese investment and small-scale commodity producers in Africa and Zambia, in particular, has a part to play in investment opportunities<sup>1</sup> and another study [4] in his assessment stated that SADC Roadmap identified agro-processing as one of its growth paths, there has been a need for concerted efforts among member states to arouse regional manufacturing competencies in agro-processing machinery, equipment, and parts and to leverage the full benefits of connections between the agriculture, manufacturing, and services sectors of the economy. More authors have different [5] views on the development of agriculture in Zambia since Zambia still has the potential to expand its agricultural production, owing to its massive resource grant in arable land, labor, and

water resources. Bordered by eight countries and being a member of the Common Market for Eastern and Southern Africa (COMESA) and the Southern African Development Community (SADC) encourages its market for agricultural produce.

Another researcher [6] has described the industrial partnership between China and Zambia mainly as involved in infrastructure development, productive capacity building, and training and education hence investing in solar milling plants. However, another research [7] explains how knowledge management and competence in strategy development, management techniques, collaboration mechanisms, knowledge sharing, and learning, as well as knowledge capture and storage, can be utilized for economic and social development in this case, how would Zambia utilize this knowledge and UNCTAD [8] explains that the bulk of ZDA investment work should be in sectors for which investors are not fully aware of the opportunities available. These are agro-processing and tourism. as stated by one research [9], perhaps the most important opportunity offered by Chinese FDI in Africa is the increase of investment in transformation activities. It is also evident that China can be very responsive to complaints by Africa stated by on one research [10].

[4] States that Demand factors examined in the paper encompass the agro-processing subsector, local consumption of maize, machinery procurement, imports of agro-processing machinery, equipment and parts, and levels of investment. Supply factors include supplier capabilities, types of machinery manufactured in the region, and the Zambian government support this idea. Hence one study [11] on the Government can do much to address social problems. They are large and powerful, with access to almost every corner of society, and through taxes, they can mobilize vast resources. Even the governments of poor countries, where tax revenues are modest, can get international funds in the form of grants and

low-interest loans hence Zambian Government investment in Solar Hammer Mills [12]. Furthermore, the ministry was confident that once the benefiting co-operatives are trained in the cooperative business model, the impact will be felt in the communities as a self-help group for poverty alleviation [13].

## **Methodology**

### **Research Design**

The research project was a socio-economic type of research that was conducted as a survey where the researcher went into the field to collect primary data. Secondary data was also used and understanding reliability and validity in qualitative research [14] meaning the research has both primary data and secondary data. The research design adopted by the researcher was a qualitative approach due to the nature of the study. This was so because the qualitative approach allows the respondents to present their views and experiences about how the solar milling plants were performing on the ground unlike relying on theories and assumptions.

This study attempted to assess how the solar milling plants were performing on the ground. Practically, were the milling plants performing to the expectation of both the program initiators who were government, the beneficiaries, and the citizen at large? Therefore, using a qualitative approach proved to be the best way for this study.

### **Population Size**

The study targeted thirty (30) co-operatives that fall under department of co-operatives in the ministry of Commerce, Trade, and Industry and members of the Zambia Cooperative Federation that were given solar milling plants under the presidential initiative program. The study was examining the solar milling plants that had been fully installed and were operational. Out of thirty co-operatives, twenty-three co-operatives were sampled to be studied as these were the co-operatives that had the solar milling plants being handed over to them, and they were operational.

Further from each co-operative, three (3) respondents were randomly selected to be interviewed. A total number of twenty-three (23) co-operatives were used to collect data in this research. The other seven (7) were left out of the study because they had not been handed over yet to co-operatives at the time of the study.

### **Sample Size**

The sample size was sixty-nine (69) respondents representing 26 of the entire population of co-operators operating solar milling plants in the Katete district. The percentage of the number of co-operatives operating solar milling plants that was used was 77%.

### **Research Instruments**

The Researcher used a questionnaire as the main data collection tool which was administered to the randomly selected co-operative members operating solar milling plants. The researcher also used an interview guide to collect data in focus group discussions and in key informant interviews. While designed instruments help in varied collect data [15] as stated by one researcher.

### **Data Collection**

The study used secondary data from the co-operative department in the district to identify co-operatives that have solar milling plants from which the respondents were randomly selected to validate it as explained by the researcher [16] for reliability and validity primary data was collected using questionnaires and interview guide. Questionnaires included mostly closed-ended questions and few open-ended questions, while an interview guide had more of open-ended questions to answer the research objectives as explain by one author [17]. The open-ended questions were used to help the researcher get the views, experiences, perceptions, and challenges of co-operatives managing the district's solar milling plants.

### **Data Analysis**

Data analysis involved reading through the questionnaire and responses to the interview guide to identify similar responses and give a general overview of the respondents are suited for this study as stated by one research [18]. The questionnaire consisted of both closed-ended questions and open-ended questions. Many questions were closed-ended, and few open-ended. All closed-ended questions were coded and analyzed into descriptive statistics, while open-ended questions were thoroughly analyzed using content and thematic analysis. The analysis was done in the form of simple counting and then converting figures to percentages for further interpretation. The analysis was manually done with no computer aid except for drawing graphs, charts, and tables. This was because the number of respondents was smaller and the research method used was qualitative, which made it difficult to use statistical computer packages like Excel and SPSS. The objectives of the research were diligently compared with the findings, and then conclusions and recommendations were drawn.

### **Limitations of the Study**

There were few notable limitations of the study. The first limitation was that the research study was conducted during the rainy season, which made data collection to be a bit difficult because, at that time of the season, members of the co-operatives were busy working in their various fields as farming was at its peak. This limitation made the researcher to follow members of the co-operatives to their various fields or wait for them to come back mainly after 14:00hrs or to come back at a later date. This in itself was time-consuming and became expensive in terms of transport cost for the researcher.

Another limitation was the much illiteracy levels among members of the co-operatives, which needed the researcher to explain the

questions in a simpler way so that respondents were able to answer or to give the correct answer to the correct question. This situation may have led the respondent to give a biased answer because it was somehow directed by the interviewer and may have somehow distorted the quality of the information collected.

## Data Presentation and Analysis of Findings

### Introduction

This chapter presents the findings and analysis of the study. The findings are presented following the research questions. The data obtained from the questionnaires, focus group discussions and key informant interviews were analysed by identifying information from data which were important for the study. The data obtained were presented in tabular form, percentages, pie chart and bar graphs. This chapter also presents the demographic information of the respondents.

### Data Presentation

The presentation has been done in relation to the demographic characteristics and following

the research questions of the study. Data is first presented and then interpreted.

### Demographic Characteristics of Respondents

The demographic information of interest to this study was: gender, age, educational level, knowledge level about solar milling plants and occupation. The demographic profile was very important to make sure that the research is studying the right audience according to the area of study. Data collected from 69 respondents sampled from different co-operatives were analysed, and the results were summarised below.

#### 4 Gender of Respondents

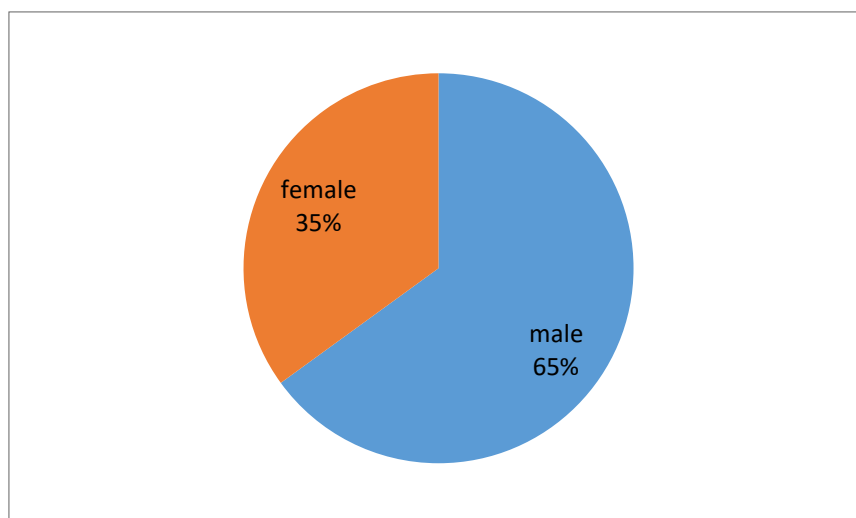
The gender of respondents was important to the study because it was used to analyze who really is mostly involved in the operation and management of the solar milling plants between the men and the women. The information on the gender of respondents was summarised in the table below.

### Results

The information in Table 1 was analyzed and interpreted in the pie chart as shown in Figure 2.

**Table 1.** Gender of Respondents

Category	Frequency	Percentage (%)
Male	45	65
Female	24	35



**Figure 1.** Gender of Respondents

Figure 1 showed that 65% of the members of co-operatives managing the solar milling plants in the Katete district were men, and 35% of them were women. The difference was just 30% to have equal participation of both men and women in managing the solar milling plant, which was not bad. However, there should be a 50/50 gender equality participation in developmental programs as the vision of our nation is that by 2030, there must be equal participation of men and women in developmental activities and decision-making positions. The study results showed that both men and women Katete

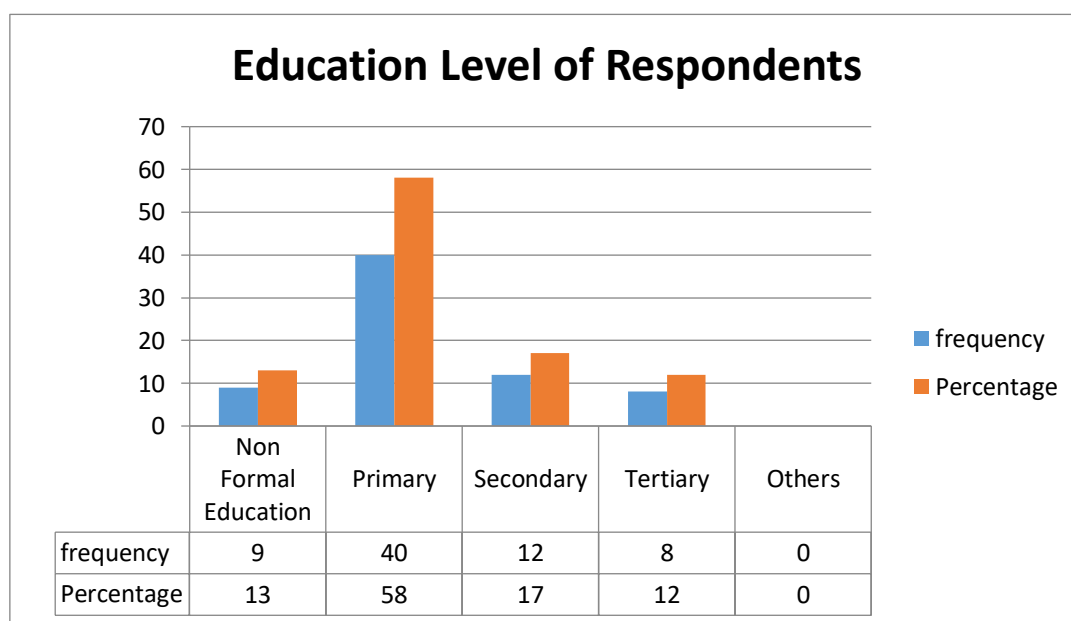
accepted, appreciated, and supported the presidential milling plant initiative, which aims to empower citizens economically.

### Educational Level of Respondents

The educational level of the respondents was of Paramount importance because education influences how co-operators perceive and implement the program of solar milling plants initiative. The data collected was shown in the following chart below. The information in Table 2 is analyzed using the chart below (Figure 2).

**Table 2.** Educational Level of Respondents

Category	Response	Percentage %
No formal education	9	13
Primary	40	58
Secondary	12	17
Tertiary	8	12



**Figure 2.** Educational Level of Respondents

The results in Table 2 and Figure 2 showed that most of the respondents in the study, 58% had primary education, which is the lowest level of education in Zambia. This could have a negative effect on the management of solar milling plants. And this could be one of the reasons why the solar milling plants project seemed not to be properly managed.

### Knowledge Level of Respondents about Solar Milling Plants

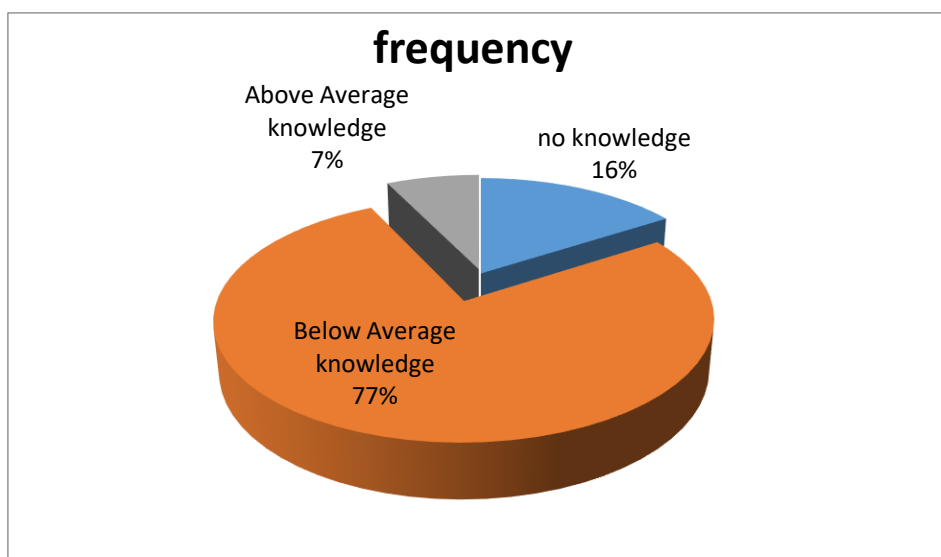
The knowledge level of respondents about solar milling plants was an important aspect to be studied because it gave an insight into how much users of the plants knew about the things they were using. This was also to better understand if users understood the program they

were involved in. The data collected on the knowledge level of respondents about solar milling plants were presented in Figure 3. The

data in Table 3 has presented in the Figure 3 pie chart, and the results were shown as follows.

**Table 3.** Knowledge Level of Respondents

Category	Frequency	Percentage
No knowledge	11	16
Below Average knowledge	53	77
Above Average knowledge	5	7



**Figure 3.** Knowledge Level of Respondents Concerning Solar Milling Plants

The results in Table 3 and Figure 3 showed that the majority of the respondents who were co-operators had little knowledge about the solar milling plants because the category of little knowledge had the highest frequency of responses which was 77%. Few had more knowledge which was 7%, and another share of 16% for those who had no knowledge about solar milling plants. The highest percentage of those with little knowledge level about the solar milling plants indicated that co-operators somehow did not understand the things they were involved in. This had a negative effect on the management of the solar milling plants.

### Occupation of Respondents

Occupation of respondents was important as it gave an indication of what proportion of the respondents were actually informal employment, informal employment, farming, and other activities. The data was important to assess the occupation of respondents as the occupation has an effect on the running of solar milling plants. Business-minded co-operators could utilise the solar milling plant as a business and not as any other thing that comes to them. Data collected was summarised in Table 4.

**Table 4.** Occupation of Respondents

Category	Frequency	Percentage %
Formal employment	0	0
Informal employment	8	12
Farming	61	88
Others	0	0



The information which was obtained showed that the majority of respondents were farmers with a percentage of 88% and informal employment with a percentage of 12%. This means that the members managing solar milling plants in the Katete district were farmers who was good because the milling plants program was meant for the farmer who could be able to produce their own maize and supply the milling plant so that they supply mealie meal on the market.

### Performance Assessment of Solar Milling Plants

The performance of the solar milling plants was considered as it was one of the specific

objectives of the study. The parameters looked at in the study were production of mealie meal per day, operation hours per day, other business activities undertaken by co-operatives associated with solar milling plant, rating of the performance of the solar milling plants. The data which was collected was summarised as follows.

### 4 Production of Mealie Meal per Day

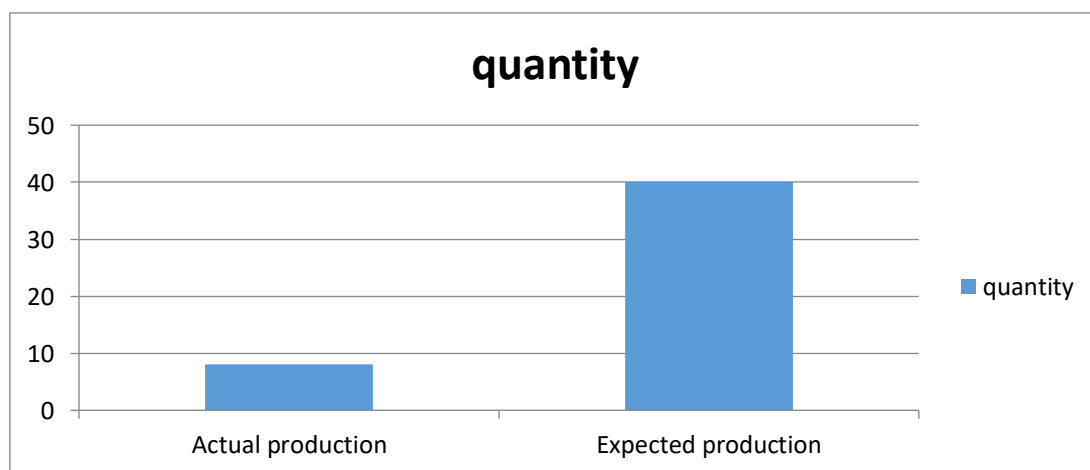
The examining here wanted to know the actual production of mealie meal bags per day and compare it to the expected production per day to help analyze the performance. The following data was gathered and presented in Table 5.

**Table 5.** Actual Production of Mealie Meal per Day

Category	Frequency	Percentage %
1-3 X 50kg	7	10
4-6 X50kg	19	27
7-9 X 50kg	35	51
10-12 X50kg	4	6
Don't know	4	6

The results in Table 5 showed that the actual production of mealie meal per day was in the range of 7-9 X 50kg bag, which was on average eight (8) bags. Therefore, the actual production of solar milling plants per day is 8 X 50kg bags. When we compare actual production to the expected production, which is 40 X 50kg bags, it is indicating that there is low production of

mealie meal because the actual production is 8 bags against 40 bags which was representing only 20% actual production. The actual production could not even reach half the expected production. Comparison of actual production verses expected production is shown in Figure 4.



**Figure 4.** Comparison of Actual and Expected Production of the Solar Milling Plants

## Operation Hours per Day

Operation of the plant was included in the study so as to assess performance. The assessment was about examining whether the plants were operating the whole day and every day. Answering to the question of whether the plants were working the whole day and every

day, 75% (52 frequency) of respondents said no they are not, while 25% (17 frequency) said yes, they are. This meant that solar milling plants in the Katete district were not operating the whole day and not every day, and not even throughout the year. Responding to how many hours in a day were the plants operating, the response given was summarised in Table 6.

**Table 6.** Operation Hours per Day

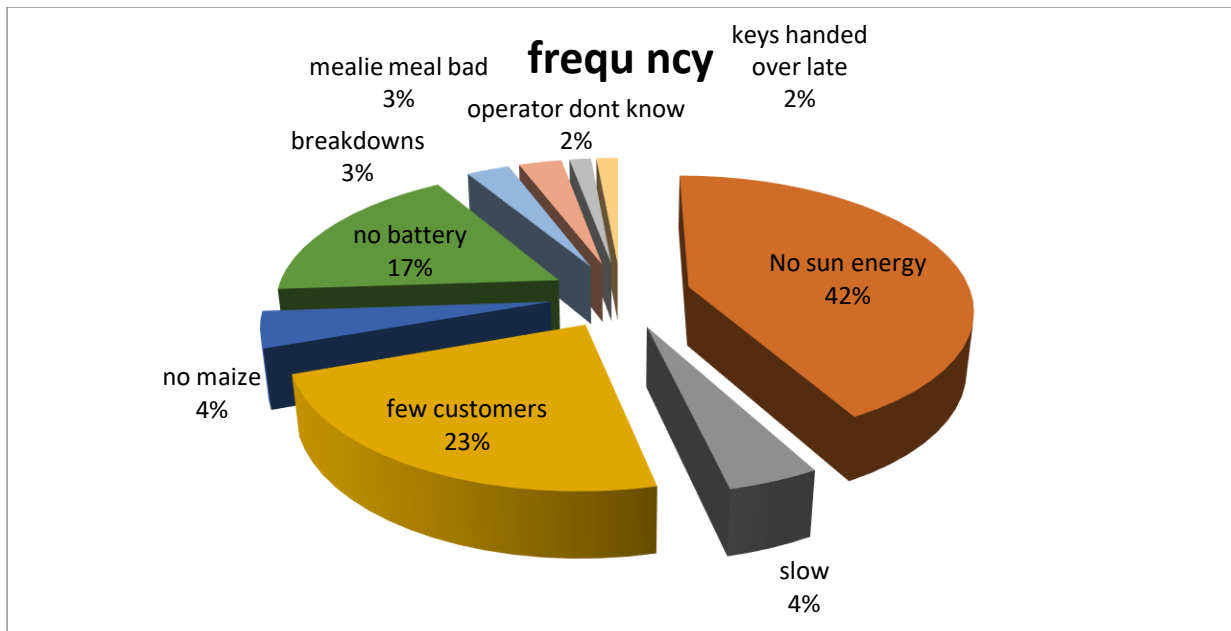
Category	Frequency	Percentage
5 hours (10-14 hrs)	28	40
6 hours (10-15 hrs)	33	48
7 hours (9-15 hrs)	4	6
8 hours (9-16 hours)	4	6

Analyzing the Table 6, the majority of the respondents said the solar milling plants operated for six (6) hours only per day, which was between 10:00-15:00 hours per day. This indicated that the plants are being underutilized as it was only operational for 6 hours which is

noon time, and the rest of the hours, the plants were dormant. However, respondents gave reasons as to why the solar milling plants were not operating the whole day and not every day and not throughout the year. The following were the reasons given in Table 7.

**Table 7.** Reasons why Solar milling Plants were not Operating the Whole Day and not every Day and not throughout the Year

Category	Frequency	Percentage
<b>Machine inefficiencies</b>		
No sun shine	29	42
It is slow	3	4
No battery to back up power	12	17
Breakdowns	2	3
Mealie meal bad taste	2	3
<b>Total</b>	<b>48</b>	<b>69</b>
<b>Others</b>		
Few customers	16	23
No maize	3	4
Operator do not know to operate	1	2
Member poor attitude	1	2
<b>Total</b>	<b>21</b>	<b>31</b>



**Figure 5.** Reasons why Solar Milling Plants were not operating the Whole Day

Analysing the reasons given by respondents in Table 7, it showed that 69% of the reasons why the solar milling plants were not operating the whole day and not every was mainly due to the machine inefficiencies. Only 31% reasons were due to other problems. The reasons are analysed in a pie chart as shown in Figure 5.

Figure 5 were the reason the respondents gave as to why the solar milling plants were not operating the whole day and not every day with no sun energy topping the list. This was because of the nature of the plants, which are solar-powered, meaning they depend on sun energy for their operation. Meaning that whenever there was no good sun day, the plants were not operating. Of course, there were other reasons as

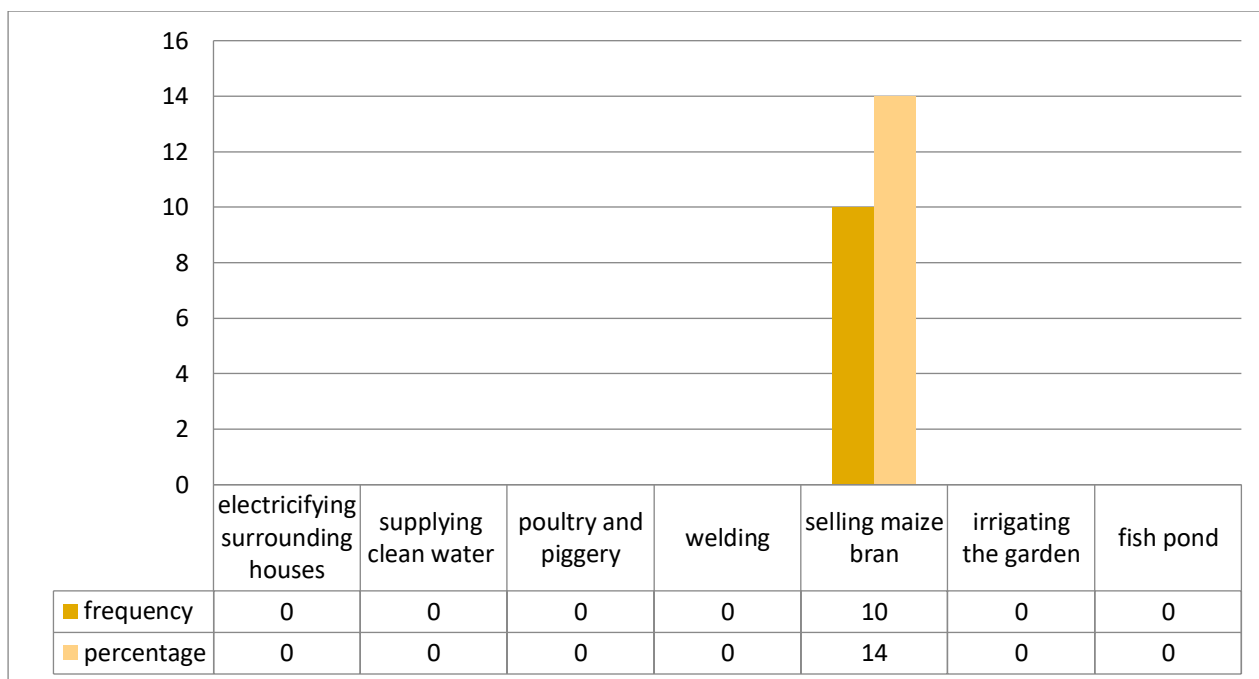
to why solar milling plants were not operating throughout, as shown in the above pie chart.

#### **Other Businesses Undertaken Associated with Solar Milling Plant**

The solar milling plants were also able to support other business activities that would increase entrepreneurial activities to sustain the co-operatives and help members raise their standard of living through additional income from those other various business activities. The investigation here was to examine if co-operatives had been undertaking other business activities resulting from the solar milling plants. The following were the responses obtained. The above information can be analysed using Table 8.

**Table 8.** Other Business Activities are undertaken by Co-operatives associated with Solar Milling Plants

Category	Frequency	Percentage %
Electrifying 25 surrounding houses	0	0
Supplying clean drinking water to the community (water kiosks)	0	0
Poultry and piggery enterprise	0	0
Welding	0	0
Irrigating the gardens	0	0
Fish ponds	0	0
Selling maize bran	10	14



**Figure 6.** Other Activities Undertaken by Co-operatives associated with Solar Milling Plants

The results analysed in Figure 6 showed that the majority of co-operatives in Katete were not undertaking any other businesses activities as the literature stipulated. Out of the seven activities that the plant could support, only one (1) activity is being undertaken to represent 14% utilization. Apart from the main purpose of grinding, the solar milling plants in Katete were not used for other business activities apart from selling maize bran.

This means that the solar milling plants were underutilized. None of the co-operatives were undertaking poultry production, piggery, fish farming, electrifying houses, water kiosks supplying clean water, welding or garden production at the time of the study even if the solar milling plants were able to support such enterprises by using the 60 solar panels to pump water that could be used for those enterprises. This was a clear indication that the solar milling plants were not used to their fullest potential.

### **Investigation how Long the Solar Milling Plants have been in Operation**

How long had the solar milling plants been in operation was vital in assessing performance as well, and it was established that 30 (43%) solar millings plants were in operation for 2 years and

the other 30 (43%) were in operation for 3 years, and the other 9 (14%) were in operation for only 1 year. This data was important to analysing performance, the more years in operational the plants were, the more reliable was the information obtained and a better judgement obtained.

In summary, analysing all the aspects examined under performance assessment, the results showed that the solar milling plants in Katete District were underperforming because production per day was far less than expected, operation hours per day was less, and most of the hours the plants were dormant, among other activities that the plant could support, all co-operatives in Katete were not undertaking any business activity apart from the major purpose of milling and selling maize bran. This clearly indicates that the solar milling plants were underperforming and underutilised.

### **Job Creation Assessment of Solar Milling Plants**

One of the objectives of the solar milling plants initiative was to create jobs for the local community. This was also another objective of this study which was to find out if solar milling plants had created jobs for the local people in the

Katete district. The parameters looked at in the job creation assessment were; the number of workers employed at the solar milling plant, working on long-term contract or temporary basis, monthly salary per worker, other workers apart from those operating the plants. These questions were important to assess whether or not the solar milling plants have created jobs in the district and, if yes, find out how many jobs have been created.

### Number of Workers Employed at the Solar Milling Plants

The investigation examined wanted to find out if the co-operatives had workers employed at the solar milling plants and to ascertain how many workers each co-operative had employed. This examination was important in assessing the employment effect of solar milling plants in the district. The gathered information was summarised and given in Table 9.

The investigation revealed that 80% of respondents said they employed workers at the solar milling plant, and this represented a frequency of 55, while those who had not employed workers at the solar milling plants were 20% representing a frequency of 14 out of 69 respondents.

In assessing how many workers had been employed by the co-operatives in relation to the solar milling plants, it was discovered that there were 46 workers employed by the co-operatives in Katete district, on average 2 workers who were an operator of the plant and a watchman.

The analysis was that there were few workers employed by the co-operatives to operate the plants as compared to what is in the literature review that there were almost five (5) workers employed by each co-operative at each solar milling plant. In that case, the co-operatives were supposed to employ 115 workers in total. In percentage form, the co-operative had employed 40% workers which didn't even reach half of the employment. However, there was potential for co-operatives to do even better because 40% of job creation was not too bad.

### 4 Employment Status of Workers

Amongst the workers employed, the examining looked at assessing what was the status of the employment created, and the results obtained were presented as follows. The following data was collected and presented in Table 9.

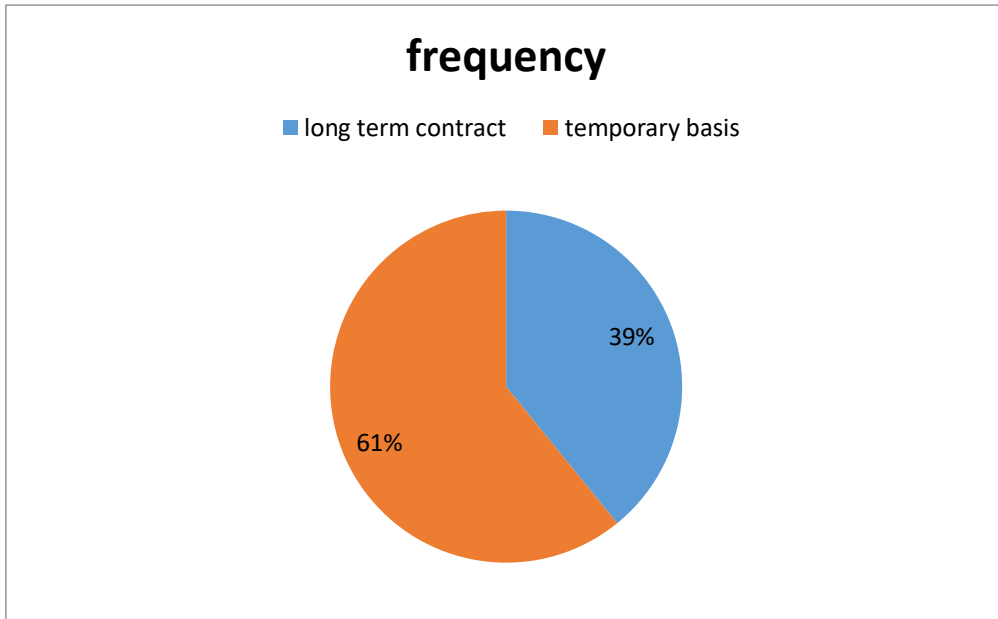
**Table 9.** Employment Status of Workers

Category	Frequency	Percentage
Long term contract	27	39
Temporary basis	42	61

The results showed in Table 9 that 39% of workers employed were on a long-term contract and another 61% were on a temporary basis. Despite that, the co-operatives had employed 40% of workers in the district; the majority of those workers were on a temporary basis, or they were casual workers which didn't give job security to workers, and casualization is against the labour laws in Zambia. Even those few who were on a long-term contract, they were not paid

on a monthly basis. The co-operatives were having salary arrears to the workers. In those months were they were paid, the co-operatives were paying its workers' salaries using shares of the co-operatives.

Analysing this data in a pie chart, the following results were shown in Figure 7. The results showed in Figure 7 that 39% of the workers were on long-term contracts, and 61% of workers were on a temporary basis.

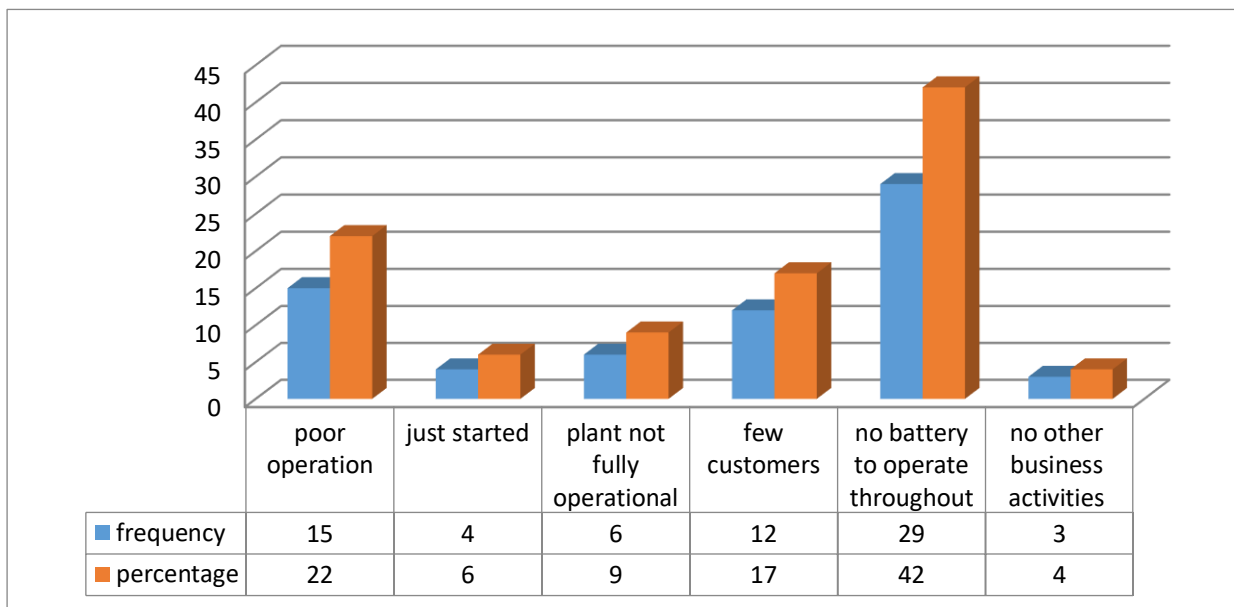


**Figure 7.** Employment Status of Workers

### Investigating Reasons why Co-Operatives had not Created more Jobs

There were various reasons which respondents gave as to why they couldn't

provide more jobs by use of solar milling plants, and the following were the data gathered (Figure 8).



**Figure 8.** Reasons why Solar Milling Plants had not created more Jobs for the Local People

These were the responses that respondents gave as to why the solar milling plant didn't create jobs for the local people with no battery to operate throughout topping the list. The battery which the plant didn't have they said could help back up power so that it could supply more

power to the plant helping to operate throughout and also help pump water to be used for various entrepreneur business activities that could help create more employment for the local people than it was currently the situation. Businesses like poultry, fishponds, piggery, garden,

welding, and selling mealie meal on a commercial basis could help in creating more jobs to the local people and generate more income by co-operators.

### **Investigating if the Co-operatives had other Workers**

The investigation was to find out if the co-operatives had other workers employed for the solar milling plants except for the operators and the watchman. The information gathered was that none of the co-operatives had employed other workers as connected to the plant except only operators and watchmen. In summary, solar milling plants created only 46 jobs 2 at each solar plant jobs, which were not even half. The co-operatives had the potential to employ more workers if more business activities were being undertaken by co-operatives.

Most of these workers were on a temporary basis and few long terms contract, and none was on a permanent basis. The salaries paid were merger salaries below the stipulated minimum wage to labour laws in Zambia. Most of the workers were volunteers in economic analysis. Job creation assessment of solar milling plants stood at 40% in the district, which was not even halfway, and this concludes that less jobs have been created.

### **Price Reduction Assessment of the Solar Milling Plants**

The other objective why the solar milling plants were given to co-operatives was to help reduce the mealie meal prices on the local market as it was expensive for the common people to afford it. The plan was that the mealie meal from the solar milling plants could be affordable on the market and could force other sellers of mealie meal brands to reduce their prices as there could be a competitor selling affordable mealie meals. This study looked at the aspect of price reduction to assess whether or not the objective of reducing mealie meal prices was met. The parameters looked at under this assessment were; supply of mealie meals on the local market.

### **4 Supply of Mealie Meal on the Local Market**

In assessing the effect of solar milling plants on mealie meal prices, it was essential that there was an investigation on the supply of mealie meals on the local market by co-operatives in the district on a commercial basis. Data that was collected was summarised as follows.

**Table 10.** Supply of Mealie Meal on the Local Market by Co-operatives

<b>Category</b>	<b>Frequency</b>	<b>Percentage</b>
Supplied	5	7
Didn't supply	64	93

The results in Table 10 show that 93% of the co-operatives had not supplied mealie meals on the market for sale on a commercial basis. This was an indication that no mealie meal had been on the market for sale from the solar milling plants. The other 7% who had produced at one time was on a small scale to display the product at functions like co-operative day and showcase the product as show exhibits and sell the product to few individuals. The results showed clearly that the mealie meal from solar milling plants was not there on the market despite the plants

being in operation for almost 3 years. This showed that there was no effect on price reduction of mealie meals on the market as a result of solar milling plants. The market price of mealie meals was still at K85.00 at the time of the study in the Katete district.

When respondents were asked about the reasons why they could not supply mealie meals for sale on the market from the solar milling plants on a commercial basis, the following were the responses given.

**Table 11.** Reasons why the Co-operatives did not Supply Mealie Meal on the market

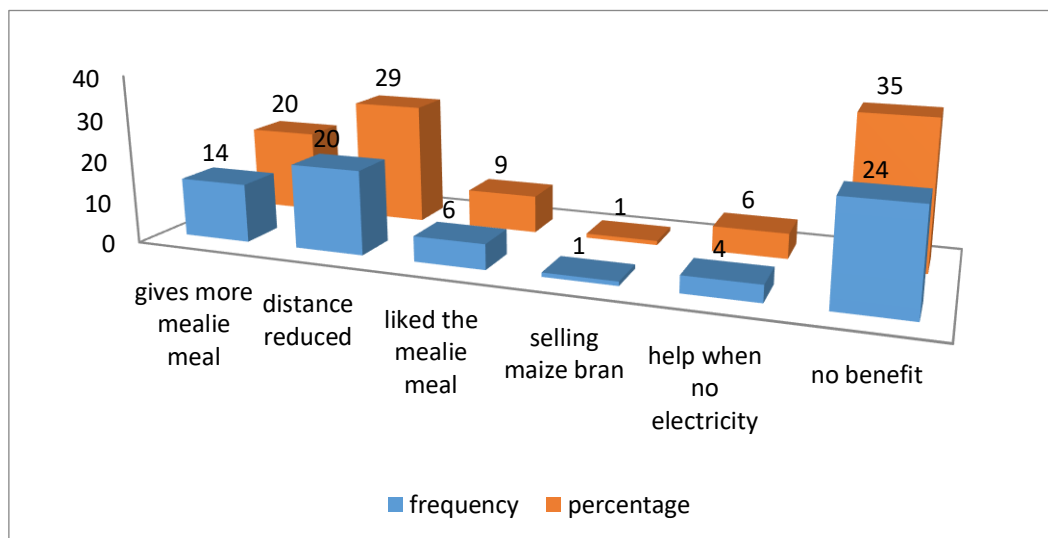
Category	Frequency	Percentage
Didn't aggregate maize	3	4
Low production capacity	3	4
No packing material	2	3
No maize for the co-operative	28	41
Doesn't produce good mealie meal	4	6
It is slow	7	10
ZCF promised to supply maize but failed	5	7
Less power supply/no battery	17	25

The above were the results obtained that respondent said they were the reasons why they couldn't supply mealie meals for sale on the market. They depended on grinding maize into mealie meals for the residents of the village who bring to the solar milling plant and not their own maize as co-operatives. Among the reasons, the top two were that they didn't have maize for the co-operative which they could grind and supply the market and secondly, the plant had low power supply which was dependant on the sun energy only which meant that a day of cloud cover, there was no grinding. However, respondents had hope that if they could supply their mealie meal on the market, eventually the mealie meal prices could have gone down because the mealie meal from co-operatives would have been relatively cheaper, forcing other sellers to reduce their prices as well. That was their view or opinion.

In summary, there was no effect on mealie meal prices by the solar milling plant in the district due to the fact that there was no co-operative that was supplying mealie meal on the local market on a commercial basis, thereby making mealie meal prices to be still high. However, there were various reasons which respondents gave as to why the co-operatives could not supply mealie meals for sale.

#### 4 Benefits of Solar Milling Plants

The investigation examined respondents to find out what benefits they had seen as a result of being given the solar milling plants, operating and managing them. The study was finding out if the co-operators appreciated and realized the benefits of the program. The gathered data was presented below in Figure 9.



**Figure 9.** Benefits of Solar Milling Plants



## Challenges and Suggestions Assessment on Solar Milling Plants

The study in this area wanted to understand the challenges that co-operatives running and managing the solar milling plants were passing through so that measures could be put in place to ensure that the solar milling plants do not become white elephants in the near future. The investigation also wanted to find out what type of training co-operators could need that could help them manage the solar milling plants efficiently and effectively. The parameters looked at in the assessment were; challenges faced by co-operators, measures to be put in place, knowledge level about the solar milling

plants, training needed, and kind of knowledge respondents wanted to know concerning solar milling plants.

### 4 Challenges Faced by Co-operators in Running the Solar Milling Plants

There were a number of challenges mentioned by respondents which co-operators were facing in the running and management of the solar milling plants, which in some way or another contributed to the failure of solar milling plants performing and bringing the economic impact as expected. The presentation of self was imperative for the leader to meet challenges. [19]. The gathered data were summarised and presented below.

**Table 12.** Challenges faced by Co-operatives in Running Solar Milling Plants

Category	Frequency	Percentage
<b>Machine related problems</b>		
No batteries to store more power	17	25
Lack of spare parts	4	6
Low solar power when cloud cover	11	16
People don't like the mealie meal	6	9
Breakdowns	3	5
It is slow in milling	4	6
<b>Total</b>	45	67
<b>Other problems</b>		
Low supply of maize	5	7
Few customers	4	6
In rainy season pay workers for free	2	3
Failing to pay workers (have arrears)	2	3
Spare parts brought late	2	3
No profit	4	6
No business plan	1	1
No operators	1	1
Not operating now hence walking long distances to grind	1	1
ZCF promised bringing raw materials but failed	1	1
The plant installed seems to be not the promised-on paper	1	1
<b>Total</b>	24	33

Table 12 shows the various challenges that were mentioned by co-operatives. The main reason topping the list was that of no battery to supply more power to the plant with 25% seconded by low solar power when there is cloud

cover with 16% and other various challenges with various percentages of representation. Analysing the two categories of challenges, which were machine-related and other problems, data collected showed that many problems or

challenges faced were mainly due to the machine itself representing 67% while those other problems were representing 33%. This meant that many of the problems faced by co-operatives in Katete district in the management of solar milling plants were about the machines themselves.

#### **4 Measures to be put in place to address those Challenges**

Respondents had given their suggestions on how the challenges that were mentioned could be addressed, and the data was presented as follows.

**Table 13.** Measures to put in Place to Address the Challenges

<b>Category</b>	<b>Frequency</b>	<b>Percentage</b>
Financial support to buy more maize	3	4
Bringing batteries	23	34
Bringing spare parts early and should be accessible in the district	7	10
Trained mechanics to repair the machine	1	1
Make feed for poultry and pigs	2	3
Open maize marketing centre	1	1
Pump water for fish pond and irrigating the garden	2	3
Need for Genset	2	3
Electrifying houses so as to do other activities like welding	2	3
Good branded packaging material	4	7
Aggregate/supply maize by co-operatives	9	14
Need to have interest as co-operators and work harder	2	3
Train other operators	1	1
Plant to be electrified	2	3
Need back up power	3	4
Open a business and sale mealie meal	1	1
Advertisements needed	1	1
Motivate operators with good salaries	2	3
Develop a business plan	1	1

The data in Table 13 shows what measures respondents suggested to address the challenges that they were facing in running and managing the solar milling plants. The major suggested measure was to bring batteries with 34% frequency to help provide more power to the plant so that it could be operational throughout even when there could be no sun energy. Seconded by 14% aggregation or supply maize by the co-operatives themselves to enable them mill and sale mealie meal on a commercial basis rather than waiting for community households to come and grind their home mealie meal. 10% of respondents suggested that the spare parts should be brought early and also, they must be made

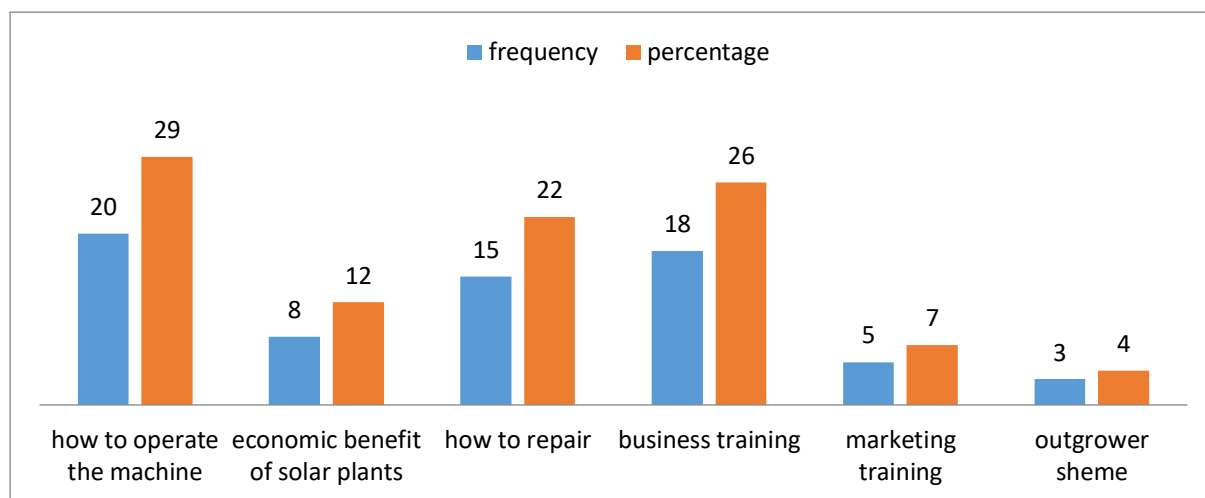
available in the district for co-operatives to easily access them, unlike what was the current situation of waiting for the Chinese to bring spare parts which took long. There were other various suggested measures as shown in Table 13.

#### **Trainings Need Assessment by Co-operators Concerning Solar Milling Plants**

The study went ahead to find out from respondents if at all they would like to have any pieces of training about solar milling plants. Because of the little knowledge level of respondents about solar milling plants, 97% of the respondents suggested that they needed

trainings in various areas, and this indicated that co-operators were ready to learn more about the solar milling plants so that they have more knowledge and understanding to help them

operate solar milling plants effectively and efficiently. The data collected on training needed was summarised and presented below.



**Figure 10.** Training Needs by Co-Operator

The results obtained in Figure 10 showed that co-operators in Katete district needed training among others on how to operate the plant and business training, which had the highest frequency and percentages of 20, 18, and 29%, 26%, respectively. The other training were economic benefits of solar plants, how to repair, and marketing training and out-grower schemes. This training was needed to help co-operators to operate, run and manage the solar milling plants initiative program effectively and efficiently.

### Kind of Information Respondents wanted to Know Concerning Solar Milling Plants

In this category, the researcher wanted to find out if at all respondents had other serious unanswered questions in which they needed information concerning solar milling plants. The data collected by the researcher was summarised and presented in Table 14.

**Table 14.** Kind of Information Co-Operators needed to Know Concerning the Solar Milling Plants

Category	Frequency	Percentage
To know how the solar milling plants are performing on commercial basis from the source which is China	8	12
To know how other co-operatives are fairing with the solar milling plants	13	19
To learn from other co-operatives in other districts who are doing well how best to improve the performance of plants	10	15
To know when the batteries are coming which we were promised	16	23
To know whether the milling plants are a loan or grant. If it's a loan, how many years will we pay back the loan	12	17
To know what happens in a case where co-operatives fail to pay back the loan	4	6
To know if ZCF will bring the raw material (maize) as promised	1	1
Nil	5	7

The above were the results (Table 14) collected about the kind of information that the co-operators needed to know concerning solar milling plants. The above results showed exactly what questions the co-operators had wanted to know about. The unanswered question with the highest frequency was wanting to know when the batteries which could supply backup power were coming as they had been promised that government would bring batteries to supply backup power. This concern had a frequency of 23% and other various concerns as tabulated in the table above.

### **Summary, Results, and Discussion of Research Findings**

In the summary, the results obtained from this research showed the following on solar milling plants in Katete District. The gender of male to female involvement in co-operatives in Katete district was 65% and 35%, respectively. 78% of co-operatives managing solar milling plants in the district were above 25 years of age, and 22% of them were below 25 years of age. The majority of respondents in the study had only primary education, which was 58% which is the lowest level of education in Zambia. The occupation of co-operators in the district running solar milling plants were farmers representing an 88% and a frequency of 61.

The actual production of mealie meal per day was 8 X 50kg bags of mealie meal, while expected production was supposed to be 40 X 50kg bags/day. The solar milling plants were operating for 6 hours in a day, and the rest of the hours of the day, the plant was dormant. The respondents gave the various reason as to why they were not operating the whole day among them were no sun energy, few customers, no batteries, and many other reasons. No co-operative was undertaking any other business-like gardening or fish farming except selling of maize bran (14%).

Most maize 87% grinded in the plant were coming from community residents and only 13% was for the co-operatives themselves.

The solar milling plants were underperforming and underutilized. However, respondents rated the performance of the plants to a score of fairs with a percentage of 43. The majority of solar milling plants have been in operational for 2 and 3 years, having a 43% each. Co-operatives in the Katete district had employed a total of 46 workers, on average 2 workers for each solar milling plant, an operator, and a watchman.

The employment status of the workers was 39% were on long term contracts, and the other 61% were on a temporary basis. The monthly salary per worker was K200.00 which was not economically sustainable. None of the co-operatives had employed other workers in connection with the plant except the operators and the watchmen. 93% of co-operatives had never supplied mealie meal from the solar milling plants on the local market, and only 7% had produced to showcase at public functions and sale afterward to few individuals.

The benefits of solar milling plants to the co-operators and the community at large included gave more mealie meals, distance reduced where to grind, and several other benefits. Machine-related problems were the major challenges faced by co-operatives representing 67% as compared to other problems representing 33%. Among machine-related problems, the highest challenge was no batteries to back up or store power with 25% and low power 5.1.

### **Conclusion**

The solar milling plants in the Katete district were under performing and were underutilised due to various challenges faced by the co-operatives which needed to be addressed. In addition, the co-operatives themselves also were not business-minded because in a period of almost three years since they were given the solar milling plants, they would have been undertaking business activities even at a small level, unlike the situation where almost nothing was happening except grinding maize for the residents of the community as a major activity

with very few co-operatives selling maize bran in very low quantities. Especially that the solar milling plants were a loan that needs to be paid back and the co-operatives managing the solar milling plants were supposed to be paying back K1, 700.00 per month for 15 years which the majority of the co-operatives are failing to raise and payback, it is very important that the milling plants utilised to the fullest potential so the co-operatives can raise more income to pay back the loan and also to improve their standard of living.

Otherwise, the government introduced a very good program which needs to be supported by all, especially the beneficiaries themselves. Co-operatives need to develop a business mind to see to it that they use the solar milling plants to the best of their ability and change their lives economically because the project of solar milling plants have the potential to change people's standard of living if only managed effectively and efficiently. The solar milling plants are economically viable, and the program was a good initiative for the rural people like the Katete district. They can help alleviate poverty levels in the Katete district to be particular especially that the plant can support other entrepreneurial activities.

## **Recommendations**

For the solar milling plants presidential initiative program to be successful, the government and other stakeholders like private sector or non-government organisations (NGO), the Zambia Cooperative Federation (ZCF), the department of co-operatives under the Ministry of Commerce, Trade and Industries, Katete District Cooperative Union (KDCU), member co-operatives themselves and the residents need to work together to support the program and see how best to do it going forward. All stakeholders may play key roles in motivating, training, and guiding the co-operatives. They can organise co-operative tours to visit other co-operatives that are doing well so that they are able to learn from others how they are utilizing the solar milling plants so as to bring economic benefits. Training

in business management and marketing can be conducted so as to help co-operatives to manage the solar milling plants efficiently and effectively.

The research examined the economic impact of the solar milling plants, further research should be done to examine what could be done to address the challenge of low energy when there is cloud cover. Engineers need to ascertain how the solar milling plants can have backup power to use especially when there is cloud cover during the rainy season and cold season, considering that Katete district is extremely cold such that there can be little or no sun energy during the cold season. In addition, ZCF should investigate further from China how they have managed to use the solar milling plants effectively since they were the source of our solar milling plants so that the nation can learn from them, maybe there is a point we are missing

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## Conflict of Interest

In this research, there was a balance between protecting sources of knowledge and a search for knowledge. The subsequent ethical rules of

research were strictly adhered to. Hence no conflict of interest. Hence no conflict of interest, as stated by one author [20].

## References

- [1] [http://www.xinhuanet.com/english/2019-01/31/c\\_137790052.htm](http://www.xinhuanet.com/english/2019-01/31/c_137790052.htm).
- [2] Mandal, A. (2005). "Swarnajayanti Gram Swarozgar Yjana and Self-help group: An Assessment" Kurukshehra. *A Journal of Ministry of Rural Development*.
- [3] Calabrese, L., & Weng, X. (2018). Chinese investment and small-scale commodity producers in Africa The DEGRP research Aims. September.
- [4] Chigumira, G. (2019). Assessment of demand in agro-processing machinery in the SADC region: A case study of the maize-milling machinery value chain in South Africa and Zambia. *WIDER Working Paper Series Wp-2019-70, World Institute for Development Economics Research (UNU-WIDER)*, September.
- [5] Mulungu, K., & Ng'ombe, J. N. (2017). Sources of economic growth in Zambia, 1970–2013: A growth accounting approach. *Economies*, 5(2), 1–23. <https://doi.org/10.3390/economies5020015>.
- [6] Konara, P., & Wei, Y. (2016). Foreign direct investment as a catalyst for domestic firm development: the case of Sri Lanka by Palitha Konara and Yingqi Wei. *Transnational Corporations*, 23(3), 32. [https://unctad.org/en/PublicationChapters/diaeia2016d2a1\\_en.pdf](https://unctad.org/en/PublicationChapters/diaeia2016d2a1_en.pdf).
- [7] Serrat, O. (2017). Knowledge Solutions: Tools, Methods, and Approaches to Drive Organizational Performance. 1–1140. <https://doi.org/10.1007/978-981-10-0983-9>.
- [8] UNCTAD. (2006). United Nations Conference on Trade and Development Investment Policy Review.
- [9] Draft, W. (2009). Impact of China-Africa Investment Relations: The Case of Zambia *Jolly Kamwanga*. November, 1–39.
- [10] Karmakar, K. G. (1999). "Rural Credit and Self-help Group, Microfinance Needs and Concept in India." New Delhi: Sage Publication.
- [11] Roy, P. (2009). Creating a World Without Poverty: Social Business and the Future of Capitalism. *Social Change*, 39(2), 299–302. <https://doi.org/10.1177/004908570903900209>.
- [12] Ministerial Statement by Mr Yaluma -04.12.18 ([https://www.parliament.gov.zm/sites/default/files/images/publication\\_docs/MINISTERIAL%20STATEMENT%20BY%20MR%20YALUMA%20-04.12.18%20%281%29.pdf](https://www.parliament.gov.zm/sites/default/files/images/publication_docs/MINISTERIAL%20STATEMENT%20BY%20MR%20YALUMA%20-04.12.18%20%281%29.pdf)).
- [13] Gadanayak, B. B. (2008). "Poverty alleviation at the grass-root level, self-help groups as an instrument" Dev4India.org.
- [14] Golafshani, N. (2003). Understanding reliability and validity in qualitative research. The qualitative report, 8(4), 597-606.
- [15] Colton, D., & Covert, R. W. (2007). Designing and constructing instruments for social research and evaluation. *John Wiley & Sons. Inc.* USA.
- [16] Thatcher, R. W. (2010). Validity and reliability of quantitative electroencephalography. *Journal of Neurotherapy*, 14(2), 122–152. <https://doi.org/10.1080/10874201003773500>.
- [17] Harper, M. (2002). "Practical Micro finance: A Training guide for South Asia". New Delhi: *Vistaar Publication*.
- [18] Harrell, M. C., & Bradley, M. A. (2009). Data collection methods. Semi-structured interviews and focus groups. Rand National Defense Research Inst Santa Monica Ca. [www.rand.org](http://www.rand.org).
- [19] Erving, G. (1959). The presentation of self in everyday life. Garden City, NY: Anchor.
- [20] Mckinney, J. A., Emerson, T. L., & Neubert, M. J. (2010). The Effects of Ethical Codes on Ethical Perceptions of Actions toward Stakeholders. 505–516. <https://doi.org/10.1007/s10551-010-0521-2>.