ANALYSIS REPORT

The following report was written by the following Macquarie University students:

Tabitha Philip	Project Lead
Rory Ali	Project Officer/ Data Consultant
Ava Gardiner	Project Officer/ Change Officer
Cassandra Johns	Data Specialist
Lachlan Yates	Business Analyst/ Change Officer

TABLE OF CONTENTS

1. EXECUTIVE SUMMARY

This analysis report presents key findings and insights extracted from the data sets of the Zoe Empowers program using SAS's Viya platform. The report focuses on three main areas: the self-sufficiency index, understanding the selected countries (Kenya and Rwanda), and the impact of the program on the economy, housing, and spiritual strengths of the participants.
In analysing the self-sufficiency index, it was found that participants who had been in the program longer significantly improved their self-sufficiency scores. A linear regression model confirmed a strong association between membership status and the self-sufficiency index. However, the analysis lacked data on participants' pre-program status and the program's long-term effects.

The analysis also explored the selected countries, Kenya and Rwanda, to understand the impact of Zoe Empowers. Different models, including neural networks and random forests, were applied to identify the most significant factors contributing to food security and nutrition. It was discovered that knowing one's rights and being able to enforce them played a crucial role in Kenya, where the right to adequate food is constitutionally guaranteed. In contrast, Rwanda's strong healthcare system contributed to addressing malnutrition.

The report further examined the program's impact on the economy. By comparing participants' income levels with the average income for small businesses, it was established that the program elevates participants' economic status, with longer membership leading to better economic outcomes. Additionally, investments in farming showed a positive correlation with economic and self-sufficiency scores.

The analysis also addressed housing, highlighting the impact of a severe drought in Kenya during 2016-2017, which affected housing conditions for participants. Post-drought recovery and increased access to water resources were associated with improved housing conditions.

Finally, the report explored spiritual strengths among participants. It was observed that religious identification, particularly Christianity and Islam, influenced spiritual strength. The analysis

showed a gradual increase in spiritual strength for participants of different religions throughout the program.

Overall, the analysis affirms the effectiveness and impact of the Zoe Empowers program in improving participants' self-sufficiency, economic status, housing conditions, and spiritual strengths. The findings provide valuable insights for the SAS Institute and support the potential recommendations that will be presented in the Recommendations Report. The program aligns with the United Nations Sustainable Development Goals and demonstrates a comprehensive understanding of the selected countries, Kenya and Rwanda.

2. INTRODUCTION

The report aims to present the most significant data trends and patterns extracted from the Findings Report and presented in the data sets utilising SAS's Viya platform. Using external resources such as the United Nations Sustainable Development Goals (SDG) it's databases and global articles pertaining to impactful events within or surrounding the elected countries.This report is to be read in conjunction with the Findings report presented to SAS Institute in order to gauge a deeper understanding of the data insights uncovered from the three presented data sets (Self-Sufficiency Index, Kenya and Rwanda). The analysis report will demonstrate reason to the potential recommendations that will follow in the Recommendations Report. Ultimately the analysis presented aims to affirm the charity organisation Zoe Empowers and the work it does as effective and impactful to its participants.

3. SELF-SUFFICIENCY INDEX

The big question: does Zoe Empower's improve the participants' self-sufficiency? Are they improving the lives of those who they set out to help?

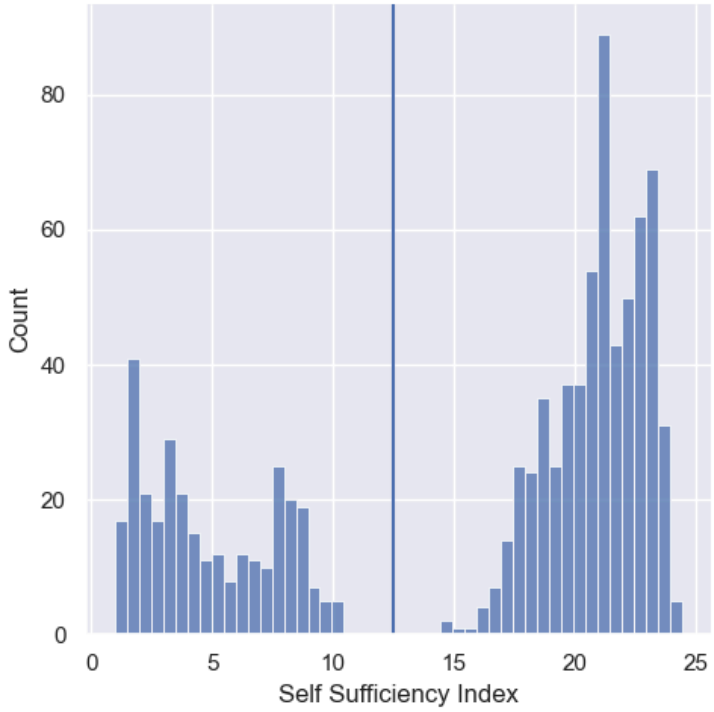

Figure 1. This is a histogram of the self-sufficiency index.

Figure 1 shows a bizarre shape with an entire section in the middle missing. This means that during the program participants jump radically from 10 and below to 15 and above.

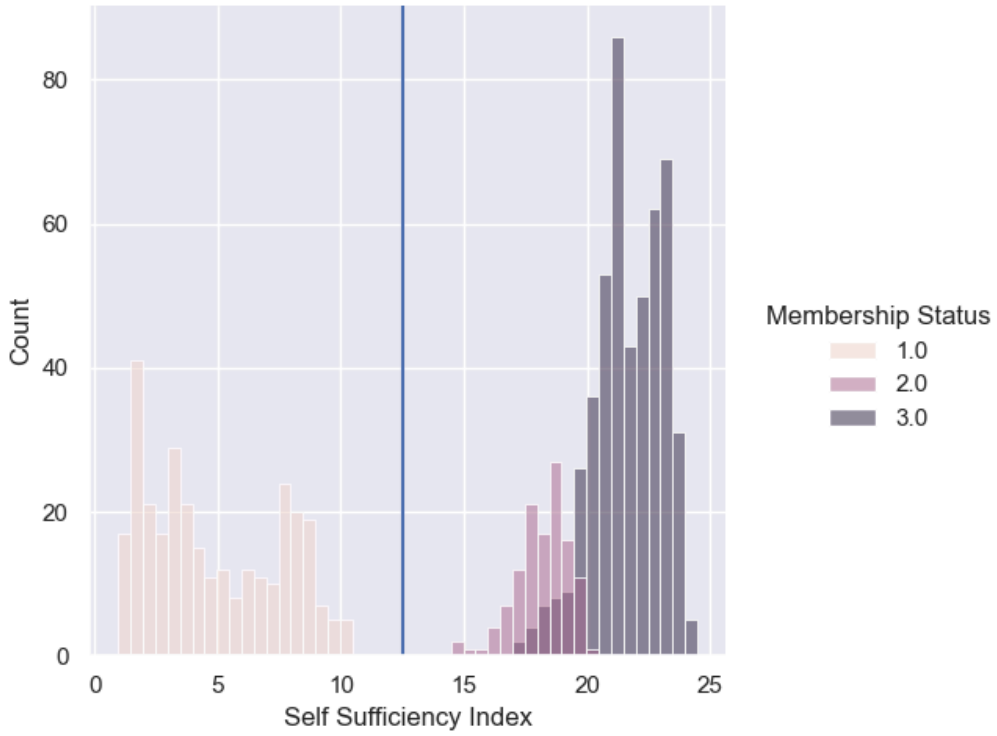

Figure 2. Colouring the same histogram by the member's duration

Figure 2 immediately shows what is happening. The membership status has been encoded:

1. Member less than 3 months
2. Member between 1 and 2 years
3. Recent Graduates after 3 years in program

Those who just started the program have a dramatic difference as compared to participants who have been in the program longer. This leads to the idea that the program directly improves the participant's SSI. Therefore to discover the relationship between these two variables in a deeper sense, we turn to a linear regression model.

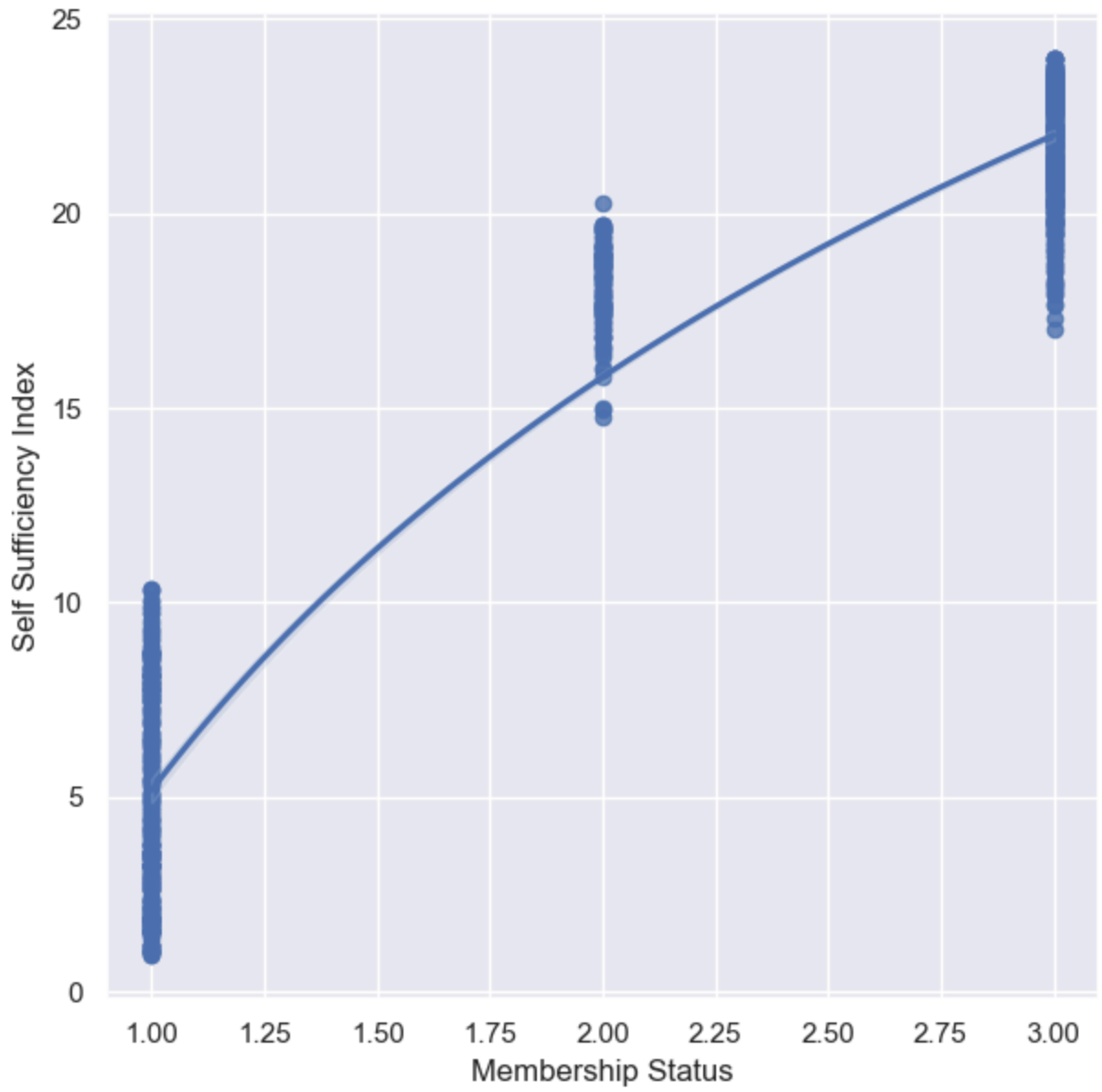

Figure 3. Log linear regression: SSI vs Membership Status

This log transformed linear regression demonstrates that there is a very strong association between these two variables. Additionally since it is log transformed it does mean there is a bigger change from status one to status two. This is a key find as there is undeniable evidence that the participants' self-sufficiency index is growing with their participation. It has statistically significant information with the R-Squared metric being 0.93 and MSE being 4. Additionally demonstrating that we could use the membership status to predict SSI.

However we have a big issue with this model. There is no information before the participants were a part of the program nor do we understand how long the effect of Zoe Empower's program is on the orphans as the information only precludes the recently starting and finishing participants.

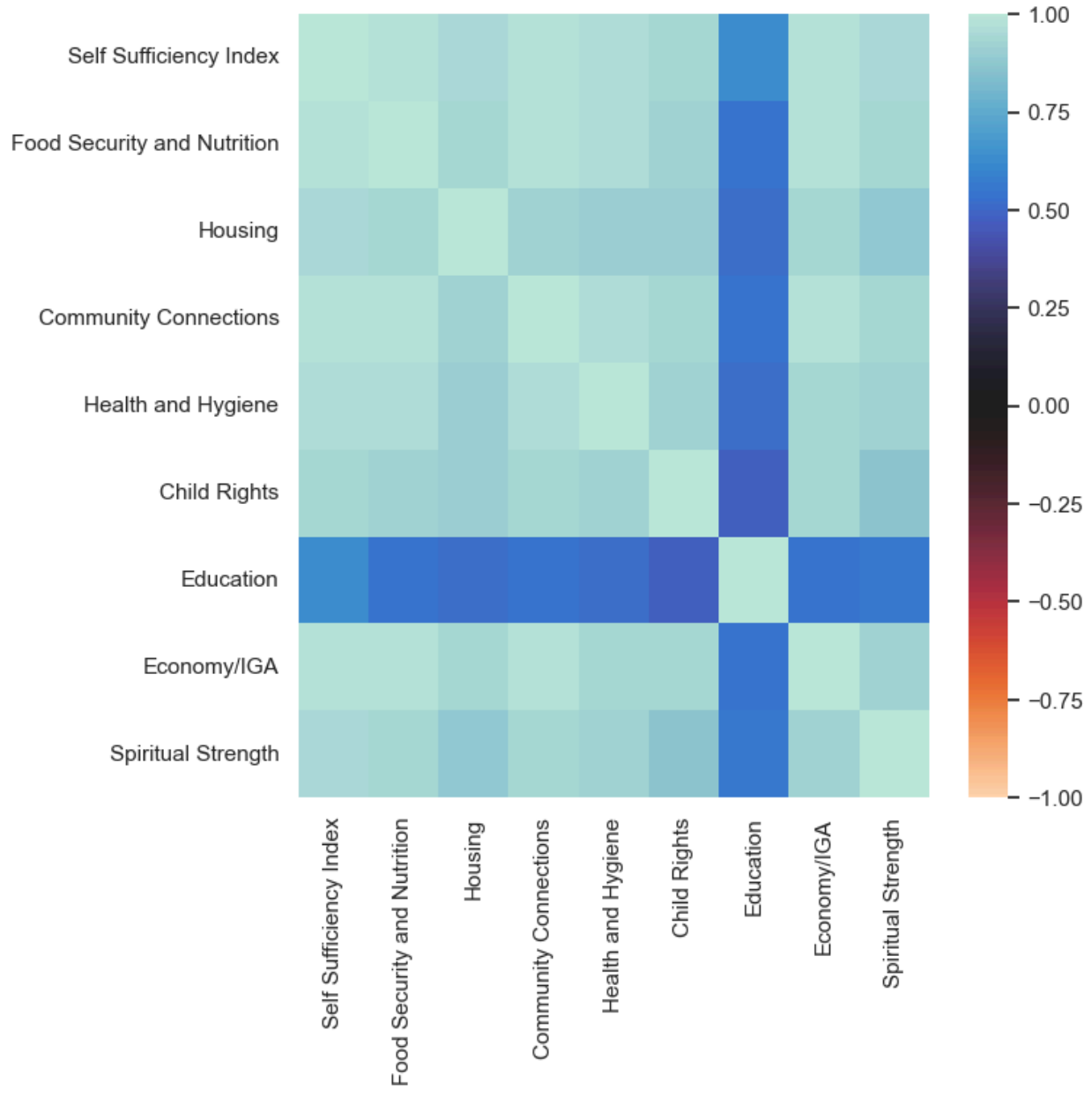

Figure 4. SSI and Correlation Matrix between the eight factors

Figure 4 is attempting to see what parts of the self-sufficiency index contribute the most and how these components interact with each other. Firstly note, there basically is no red. It is all blue. And blue means positively correlated. This means that as one category improves, all others tend to improve. Note also that Education was lacking behind, from our analysis this is most likely due to data issues rather than a significant change in information as this category was filled with NAs. To dig deeper into that understanding would require us to understand how exactly the data was procured.

4. UNDERSTANDING THE SELECTED COUNTRIES

To understand exactly what Zoe Empower's was doing and how they were being effective we needed to relate the SSI and Categories to the questions provided in different data sets.

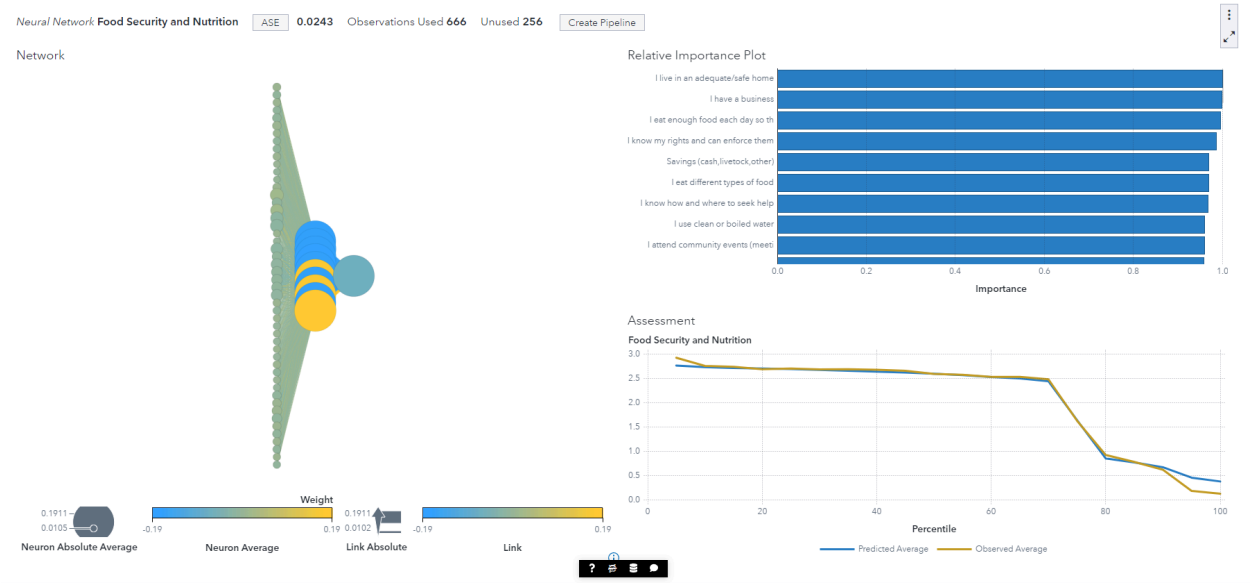

Figure 5: Neural network contributing to relative importance of Food Security and Nutrition

Initially started with using a neural network as described by Johnathan Butow. We produced a neural network attempting to understand the relevant answers to the Food Security and Nutrition, Figure 5. This involved removing the other category variables to prevent them from interfering with the significance of the questions. Figure 4 already showed that all the eight categories are highly correlated and would show up as significant variables to this category. The neural network

was outputting in the relatively important plot, things that did make sense, however didn't seem quite right. "I eat enough food each day…" should be more significant than living in an adequate home, therefore further investigation was needed.

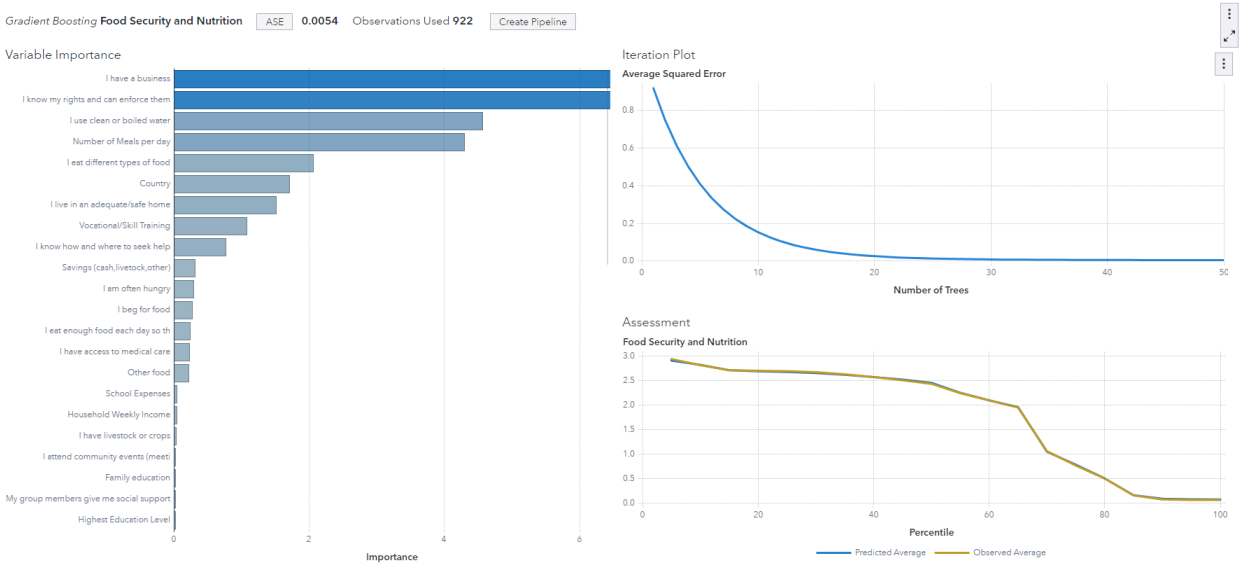

Figure 6: Gradient Boosted Forest for Food Security and Nutrition

The next model that was tried was a gradient boosted forest model. Figure 6 shows the output for Food Security and Nutrition. Throughout applying this model to the other eight categories, "I have a business" and "I know my rights and can enforce them" were dominating every category. Gradient boosted forests have a weakness with multicollinear indexes due to its improvement process. Figure 7 shows that almost every index is strongly correlated with each other.

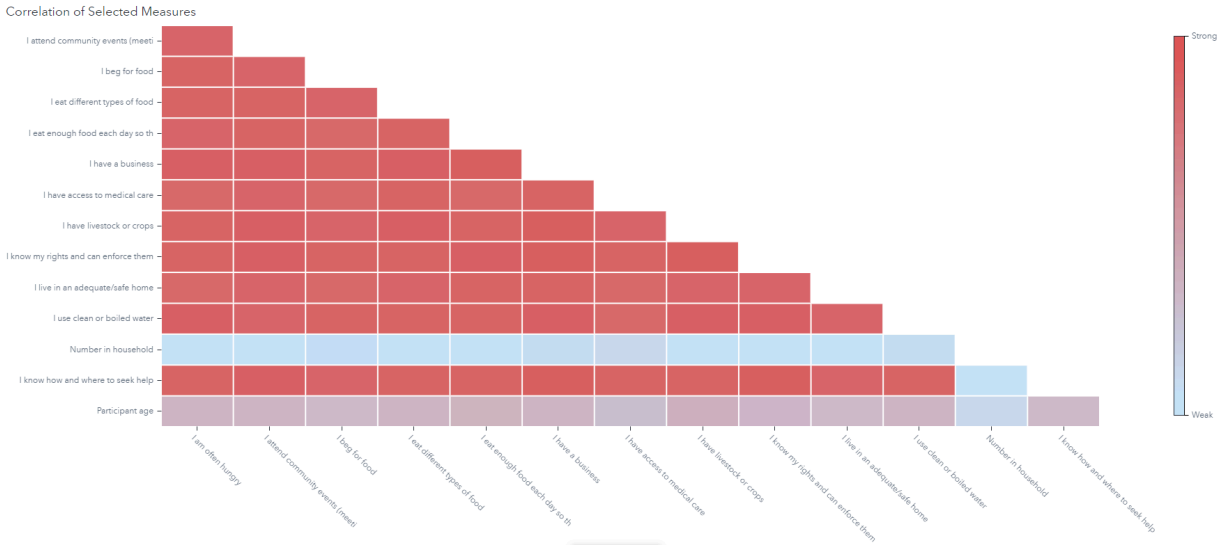

Figure 7: Correlation of questions

Lastly I moved to the random forest method that would mean that the collinearity would have less of an impact as its approach is through averaging across all generated trees. I tuned the hyperparameters to have a lower bootstrap to increase the randomness and lower the effect of the collinearity and also a reduced amount of trees to help prevent overfitting and get a more generalised view of the important factors.

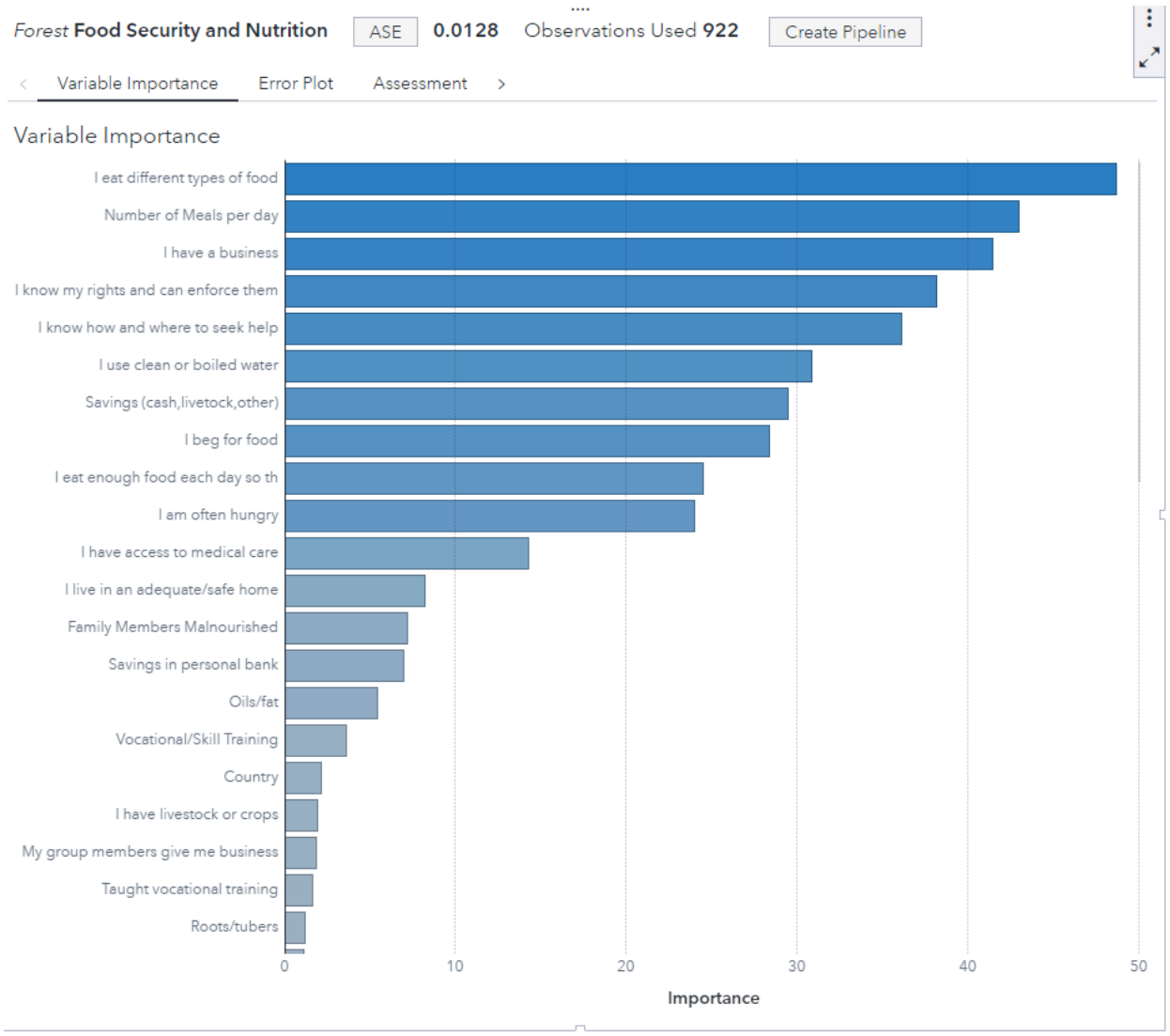

Figure 8: Random forest model of Food Security and Nutrition

However, "I know my rights and can enforce them" continued to appear as a significant effect on the categories across the board. Although no longer dominating, with other variables starting to move their way up into more important positions, I saw this as an indicator that there was something more significant about the impact of knowing your rights then I would have initially thought.

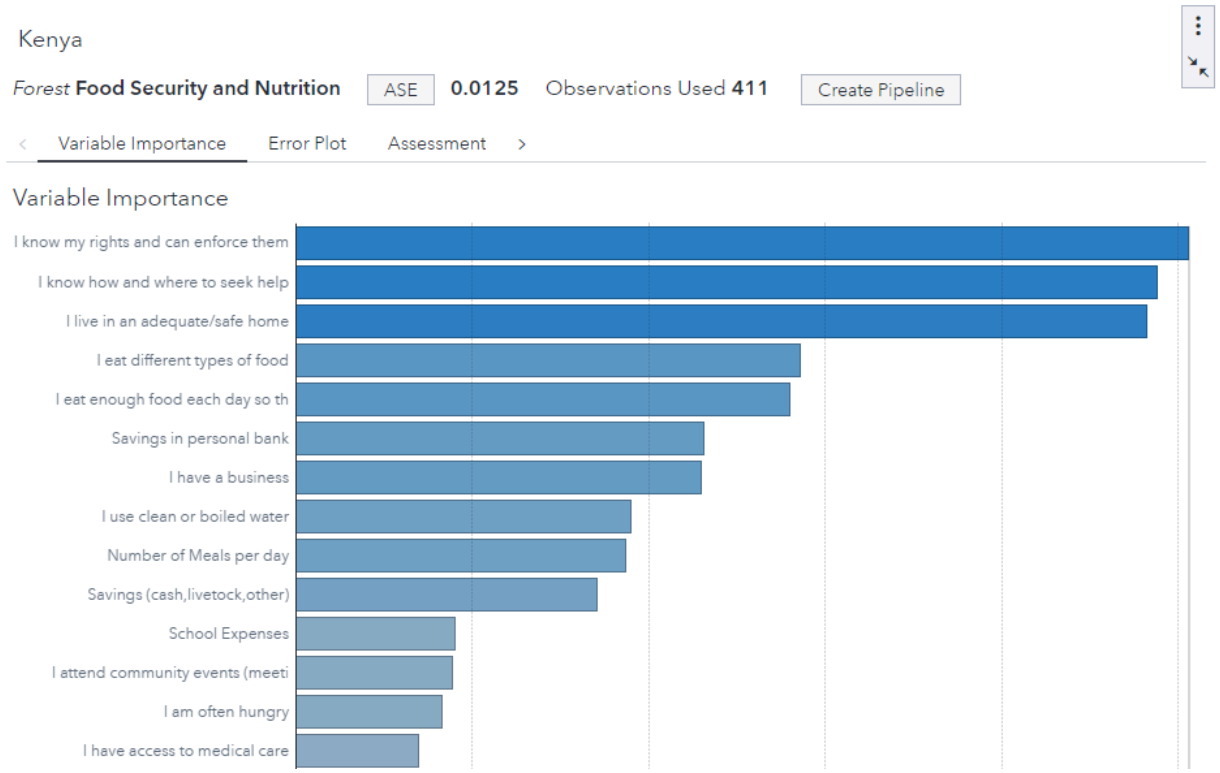

Figure 9: Random forest model for Kenya's Food Security and Nutrition

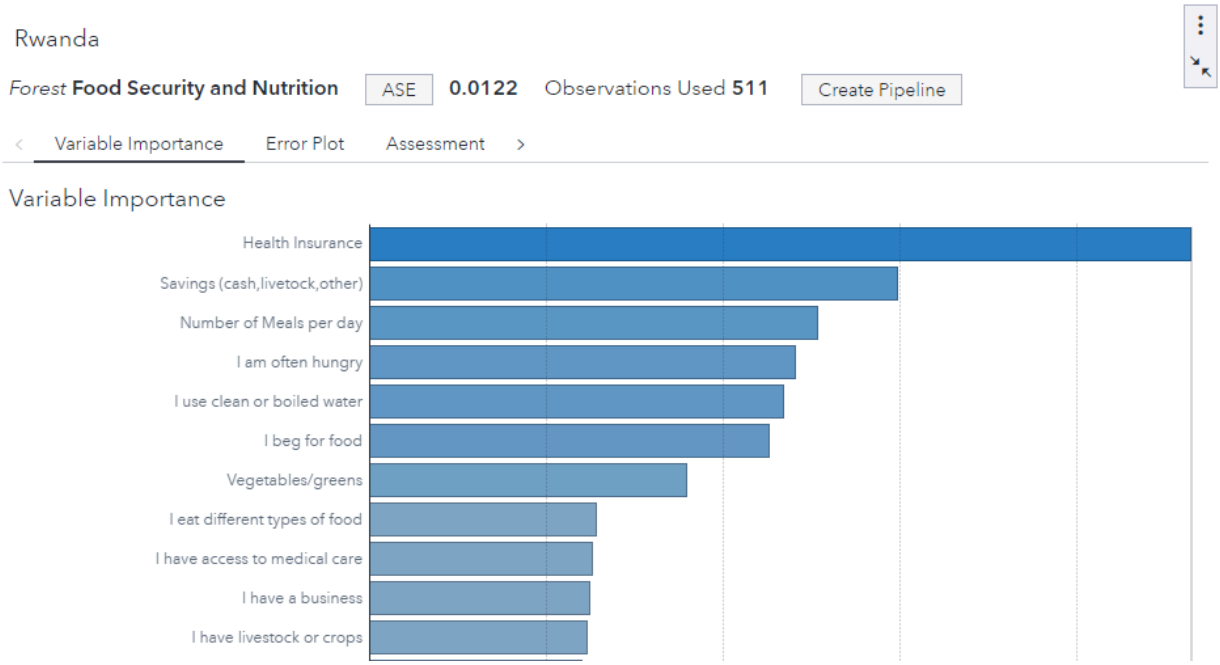

Figure 10: Random forest model for Rwanda's Food Security and Nutrition

Kenya had "I know my rights and can enforce them" at the highest of importance, where Rwanda does not. Suddenly I understood that different countries could see the right to food as a human right or not. After some external research according to the Food and Agriculture Organisation of the United Nation:

- "The Constitution of the Republic of Kenya **explicitly guarantees** the right to adequate food" (United States, 1975).
- "The Constitution of the Republic of Rwanda **does not explicitly guarantee** the right to adequate food" (United States, 2008).

Which means that the people of Kenya knowing their right to food and being able to enforce that means they will be getting adequate food! However the simple category of "Knowing their rights and how to enforce them" is a greatly inclusive statement. There are many rights that an individual needs to understand and work with. On the other hand, Rwanda has an incredible health care system that allows everyone access to health care, leading them to have medical intervention when struggling with malnutrition (Rosenberg, 2012). This demonstrates that Zoe Empowers do understand the countries that they are working with and how best to help those orphaned citizens.

5. ECONOMY

The economic score of an individual is often a lynchpin for which other scores can me monumentally shifted. Through conclusions drawn by the findings report it is clear that time in the Zoe Empowers program drastically improves a participants economic status. From collating external data through research by financial sector deepening in Kenya and also the Rwandan biomedical centre, both outreach and research companies that receive grants by the bill and melinda gates foundation, it is stated that the average income for a sole employee small business is around $48 per week (Financial sector Deepening. 2022) (Rwanda Biomedical Centre. 2022). Using this as an acceptable baseline, how do we prove that the program elevates participants to this average threshold and beyond?

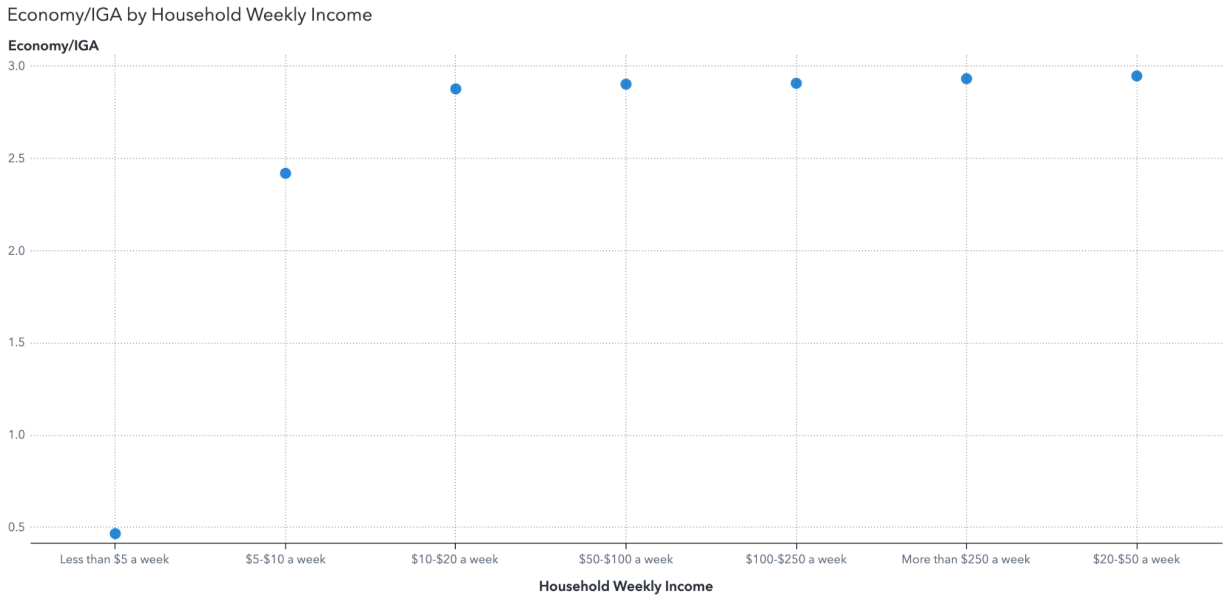

Figure 11: Dot plot of Food Security by Household Weekly Income

To start we needed to first determine the economy score to which this sustainable income can be attributed to. Trying to match this to the average income we see that anywhere between a score of 2.4-2.8 will represent an individual meeting the average monthly income. Anything above will be exceeding average. Many of the proceeding graphs will be linked also with the food and nutrition values also as established with the findings report these two factors are heavily linked with the economy score understandably heavily affecting a participants food score also.

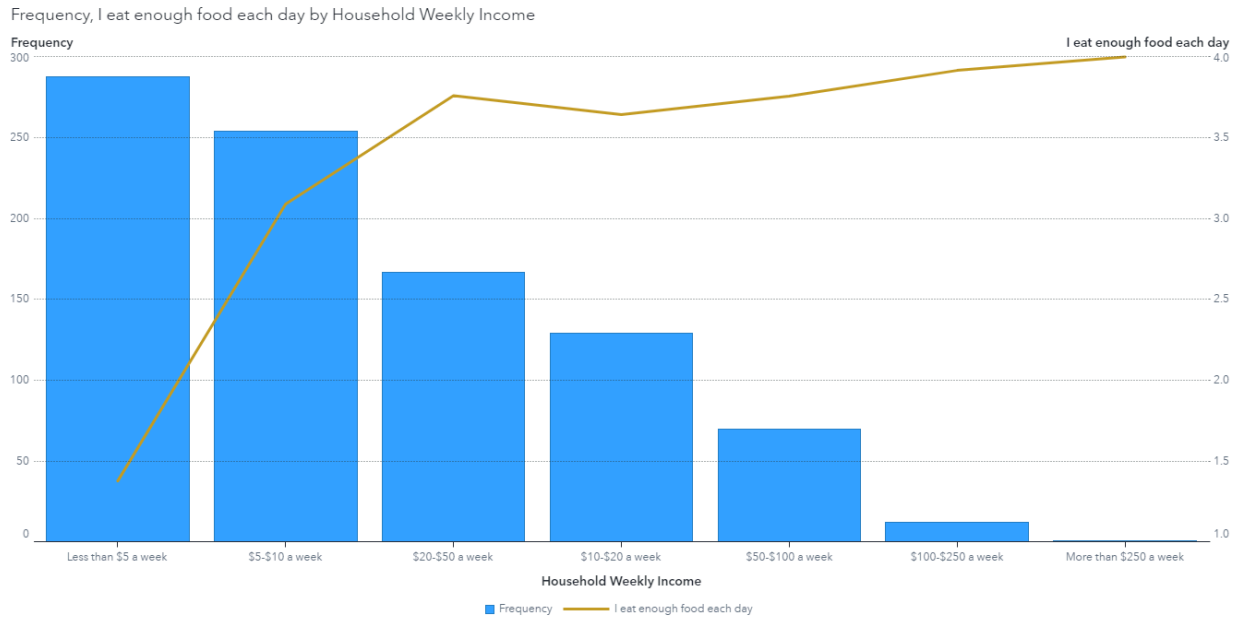

Figure 12: Dual-axis bar line graph of Food each day and Household Weekly Income

Figure 12 shows us a comparison between three metrics, income, food availability and also frequency. We can see that the jump to the average $10 a week also brings with it the largest substantial jump in food score. This must mean that this income threshold is enough for them to break the poverty line and provide themselves with basic food needs.

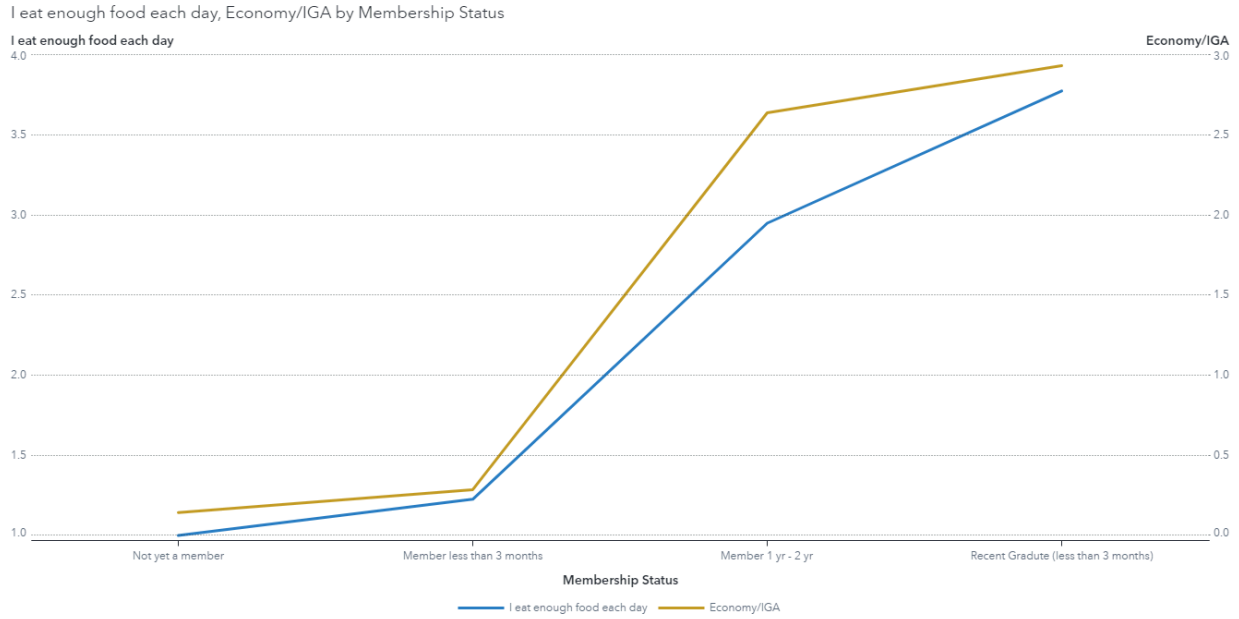

Figure 13 Dual Line chart Economy/IGA vs Membership Status

Figure 13 represents how the membership status trends with these scores. As already proven in the SSI section we again see how time within the program has a clear positive impact on an individual showing the zoe empowers project is a constructive and immense opportunity for participants.

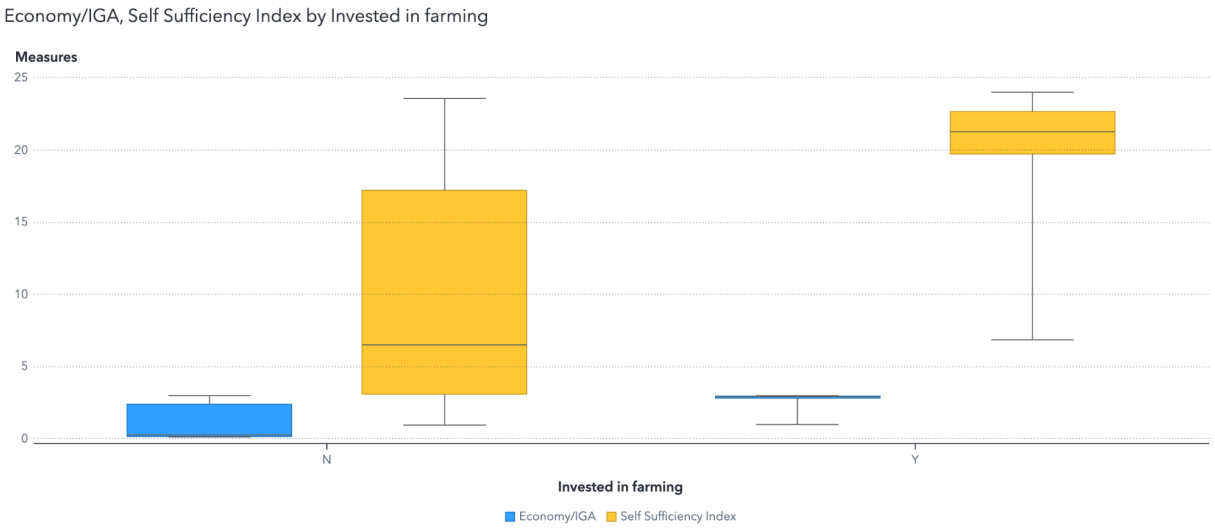

Figure 14: Box plot of Economy/IGA by SSI and Farming Investment

If the participant does not live in an urban centre the program will instead implore the individual to learn about farming and teach them how to run a sustainable farm which they can use to both make money and also provide for themselves. Figure 14 also shows that this too is an extremely viable education avenue for Zoe Empowers participants, with those having invested in a farm or farming goods jumping to the top of both economic and self-sufficiency scores.

6. HOUSING

Drawing on Figure X from the Findings report we were able to identify a notable discrepancy between the membership status of less than three months and one to two years with a decrease of 20.06%. Following this finding the team did some further investigation and found that the discrepancy was most likely due to the severe drought that affected Kenya in 2016-2017 (Oolo, D. 2017). This event pertains to the timeline of participants within the program period of 2015-2018. The drought began in December of 2016 and was declared a national emergency by the Kenyan Government in April 2017 (Oolo, D. 2017). An article by the Climate and

Development Network covered the statistics regarding this noting that only 20% of the country received sufficient rainfall during the period (Global, C. 2017).We can observe a dramatic increase towards the end of the program's timeline with participation greater than 2 years . The correlation and frequency percentage between the prescribed factors has increased by 40.23% suggesting increased recovery and sustainability with water supplies post drought.

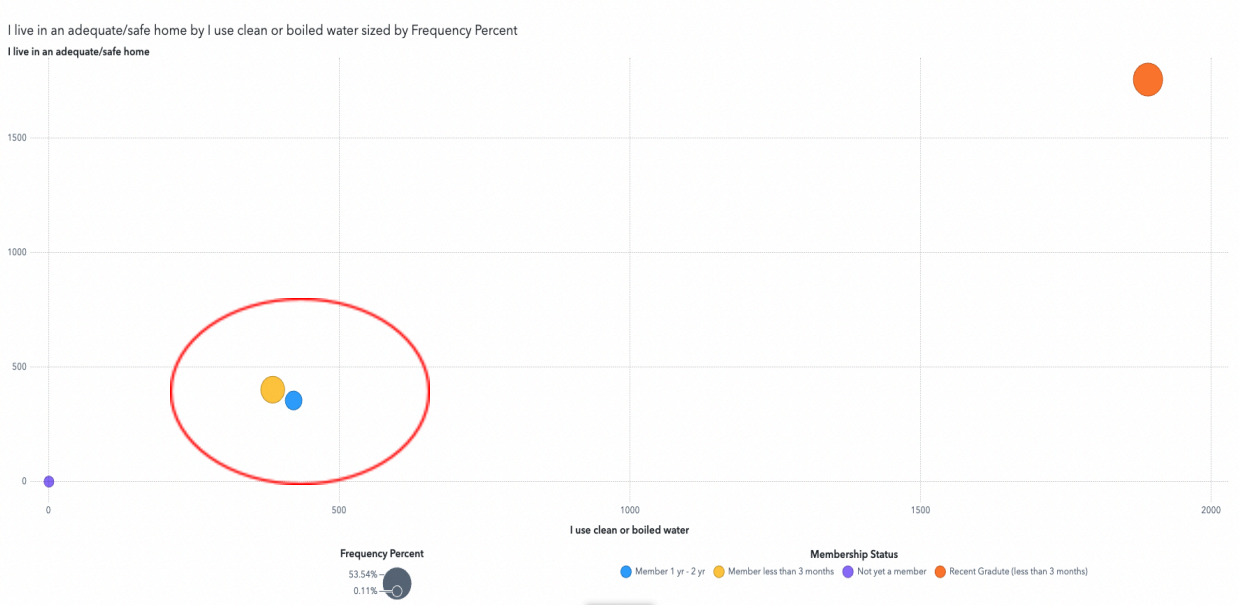

Figure 15: Bubble plot of 'I live in an adequate/safe home' vs Access to water

It should be noted that Data Synergy were unable to locate data regarding this environmental event turning to UNICEF and Relief Web reporting to source this information. The team were also unable to uncover any reporting post-disaster such as impact, response or recovery statistics/data.

In relation to external efforts the Zoe Empowers program has been seen to successfully contribute to the UN's SDG number six and eleven (Nations, 2016). Number 6 entails the goal of attaining clean water and sanitation and number eleven focuses on sustainable cities and communities. Through the correlations across these two factors we are able to observe Zoe impacts both within the program and globally.

The SAS team may be interested to see how the bubble plots' linear relationship with membership status mirrors that of the SSI vs membership status relationship described in Section 3. This further supports the notion that Zoe Empowers is impactful through its eight categories with an increase of accessibility and an individual self-sufficiency.

7. SPIRITUAL STRENGTHS

The measurement of spiritual strength at a glance could be perceived as a measurement that holds stagnant based on an individual's chosen religion e.g. practising Muslims may have high levels of spiritual strength before and after undertaking Zoe Empowers. It can be noted that measuring the spiritual strength of individuals in Zoe Empowers with 'No Religious Identification' and 'Other', will reveal little to no effect on an individual's spiritual strength. This little to no effect allowed for closer investigation for individuals of 'Christian', 'Muslim', and 'Other' religious identification. Religions may see higher levels of practice and devotion, where individuals within a religion may have higher levels of spiritual strength, and factors from the Zoe Empower's program does little to alter/enhance their established high levels of perceived spiritual strength.

Research was conducted to reveal the prevalence of religions across Rwanda and Kenya. The 'Rwanda 2019 International Religious Freedom Report' states that within its 12.5 million population, 44% are catholic, 38% are Protestant (Anglican, Pentecostal, Baptist, Methodist, Episcopalian, evangelical Christian churches), and only 2% are muslim. The '2020 Report on International Religious Freedom: Kenya' reported within its population of 53.5 million, 85.5% is Chrisitan, and 11% are Muslim. Statistics across both countries reveal a significantly larger religious demography of Chrisitan to Muslim. Evidently there's a larger proportion of Christian denomination, and a significantly lower branch of Muslim across both Kenya and Rwanda. The Zoe Empowers program states an awareness of ensuring non-discriminatory favouring of particular religions within the program, stating 'While Zoe Empowers is a religiously non-restrictive program, children experience the gospel in both action and words in ways that are always inviting but never coercive' (zoempowers.org, 2023) Understanding the percentage of particular religions within each country allowed the team to then analyse how much emphasis was placed on cultural practice within each.

Both Rwana and Kenya's constitution 'prohibit religious discrimination'. Both constitutions also 'provide freedom of religion and worship'. The ability to exercise religion freely informed our team that enforced religious practice wasn't enforced heavily in Kenya and Rwanda. This understanding afforded us further recognition that Zoe Empowers has the potential to help participants foster better religious practice and devotion, and attribute to increasing their spiritual strength.

To appropriately analyse the impact of Zoe Empowers on Spiritual Strength, a line chart was developed in Viya to segment each religion. Segmenting each religion visually revealed an increasing level of spiritual strength across religions of Christianity, Muslim, traditional/indigenous, and other, with each year in the program. The line chart helped diminish the understanding that individuals would enter the program with higher levels of spiritual strength, remain constant, and finish at a similar level.

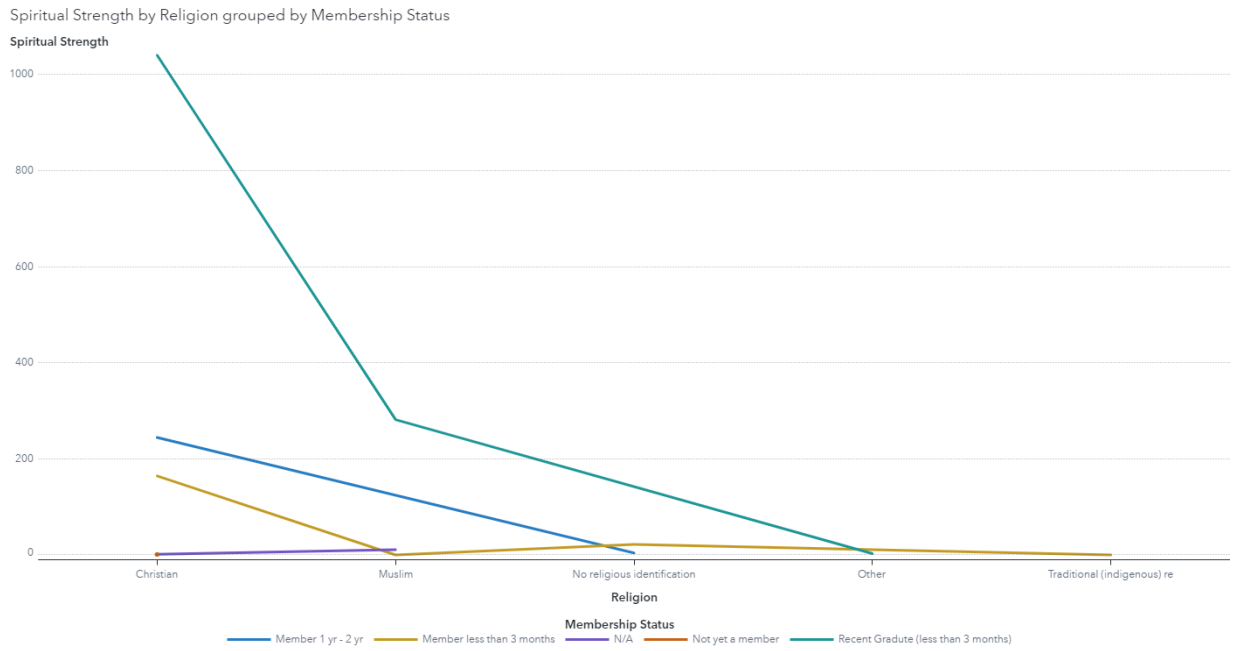

Figure 16: Line chart of Spiritual Strength and Religion

The line chart showcases a growing level of spiritual strength within each religion for each year a participant is in the program. The increase in spiritual strength across religions with each year in the program are as follows:

Religion (Christian)

Membership Status	Spiritual Strength
N/A	1.5
Less than 3 months	164.3
1 yr - 2 yr	244.4
Graduate (less than 3 months)	1039.75

Religion (Muslim)

Membership Status	Spiritual Strength
N/A	11
Less than 3 months	0
1 yr - 2 yr	140 approximately
Graduate (less than 3 months)	281.5

No Religious Identification

Membership Status	Spiritual Strength
N/A	0
Less than 3 months	22.05

1 yr - 2 yr	4
Graduate (less than 3 months)	150 approximately

SAS might be interested in ensuring that unbiased teachings of gospel remain uncoercive as stated on their website. This will work in upholding Kenya and Rwanda's constitution and ensuring an array of participants across different religions can 'find joy and meaning in collective prayer and feel confident attending worship', fostering growth in spiritual strength. This too works to uphold the United Nations Sustainable Development Goal of 'Reduced Inequalities'.

8. CHILD RIGHTS

The conclusions drawn from the findings report reveals that participants of Zoe Empowers experience an increase in Child Rights with each progressive year within the program. We can make note that more participants feel they know their rights and can enforce them only after recently graduating the program. Whereas there is very little increase in that understanding for 'Members less than 3 months' and 'Members 1yr - 2yr'. Zoe Empowers might like to increase their focus on educating participants on their rights more heavily at the midway mark of the program to increase these numbers at a more linear/progressive rate.

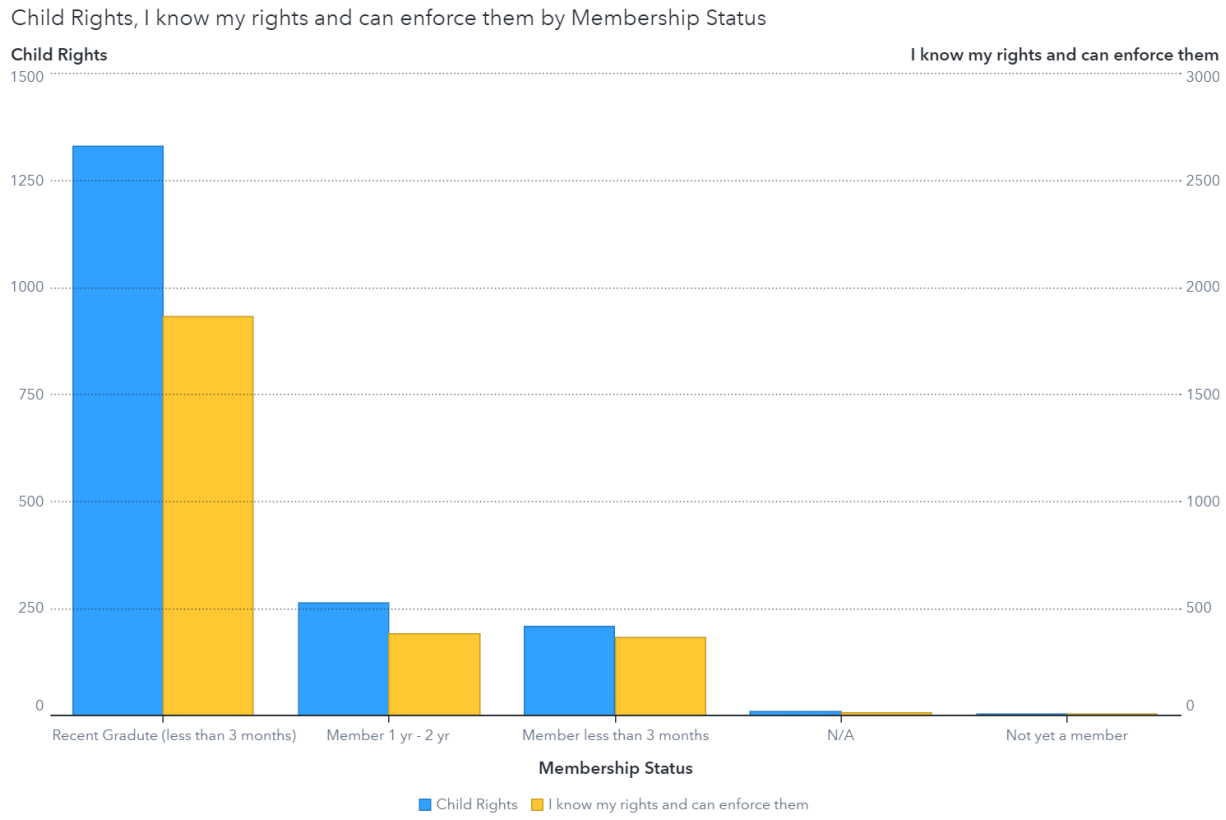

Figure 17: Dual axis bar chart of Child Rights and Membership status

The dual axis bar chart depicts the connection between 'child rights' and 'I know my rights and can enforce them'. The y-axis represents 'child rights', demonstrating an increase in an individual's child rights with each progressive year in the Zoe Empowers program. The secondary y-axis represents 'I know my rights and can enforce them', also demonstrating an increase for individuals in the program with each level of membership status. Developing each axis allowed for effective visual comparison and representation, where we could identify the chance for linearity in the 'Member 1yr - 2yr' mark of the Zoe Empowers program.

9. CONCLUSION

In conclusion, this analysis report provides valuable insights into the impact and effectiveness of the Zoe Empowers program. The findings highlight the program's positive influence on participants' self-sufficiency, economic status, housing conditions, and spiritual strengths.

The analysis of the self-sufficiency index reveals a significant improvement in participants' scores with longer membership in the program. Linear regression analysis confirms a strong association between membership status and self-sufficiency index, indicating the program's positive influence on participants' self-sufficiency.

Understanding the selected countries, Kenya and Rwanda, further emphasises the program's effectiveness. The analysis demonstrates that knowing and being able to enforce rights, particularly the right to adequate food in Kenya, plays a crucial role in improving food security and nutrition. Additionally, Rwanda's strong healthcare system contributes to addressing malnutrition.

The program's impact on the economy is evident, with participants experiencing an elevation in their economic status. Investments in farming show a positive correlation with economic and self-sufficiency scores, emphasising the value of agricultural education and sustainable farming practices.

The program has positively impacted housing conditions, although the severe drought in Kenya during 2016-2017 temporarily affected housing conditions for participants. The recovery and increased access to water resources post-drought have improved housing conditions.

Spiritual strengths among participants are influenced by religious identification, such as Christianity and Islam. While participants of these religions maintain high levels of spiritual strength throughout the program, individuals with no religious identification or "Other" religion show little effect on their spiritual strength.

Overall, the analysis affirms the effectiveness and impact of the Zoe Empowers program in improving participants' lives across multiple dimensions. The findings provide valuable insights for the SAS Institute and support the potential recommendations that will be presented in the Recommendations Report. The program aligns with the United Nations Sustainable Development Goals and demonstrates a comprehensive understanding of the selected countries, Kenya and Rwanda.

10. RESOURCES

Oolo, D. (2017) *In Kenya, severe drought threatens to leave 4 million food insecure*, *UNICEF*. Available at: https://www.unicef.org/stories/kenya-severe-drought-threatens-leave-4-million-food-insecure (Accessed: 20 April 2023).

Global, C. (2017) *The drought in Kenya, 2016–2017 - kenya*, *ReliefWeb*. Available at: https://reliefweb.int/report/kenya/drought-kenya-2016-2017 (Accessed: 29 May 2023).

Zoe Empowers.org (2023) *Empowering vulnerable youth to break the cycle of poverty*, Zoe Empowers. Available at: https://zoeempowers.org/what-we-do/. (Accessed: 28 May 2023).

U.S. Department of State (2021) *2020 Report on International Religious Freedom: Rwanda.* Available at: https://www.state.gov/reports/2020-report-on-international-religious-freedom/kenya/#:~:text=The%20government%20estimates%20as%20of,to%20various%20traditional%20religious%20beliefs. (Accessed 20, Jun. 2023)

U.S. Department of State (2019) *2019 Report on International Religious Freedom: Rwanda.* Available at: https://www.state.gov/reports/2021-report-on-international-religious-freedom/rwanda/ (Accessed 15 Jun. 2023)

Financial Sector Deepening Kenya. (2022). *FinAccess household surveys - Financial SectorDeepeningKenya*.[online]Availableat:https://www.fsdkenya.org/category/finaccess/finaccess-household-surveys/ [Accessed 20 Jun. 2023].

Rbc.gov.rw. (2023). *Rwanda National Health Research Registry*. [online] Available at: https://rbc.gov.rw/rnhrr/ [Accessed 20 Jun. 2023].

Nations, U. (2016) *The 17 goals | sustainable development*, *United Nations*. Available at: https://sdgs.un.org/goals (Accessed: 20 April 2023).

United States, F. and A.O. o (1975) *Fao.org*, *RWA | The Right to Food around the Globe | Food and Agriculture Organization of the United Nations*. Available at: https://www.fao.org/right-to-food-around-the-globe/countries/rwa/en/ (Accessed: 01 June 2023).

United States, F. and A.O. of (2008) *Fao.org*, *Countries | The Right to Food around the Globe | Food and Agriculture Organization of the United Nations*. Available at: https://www.fao.org/right-to-food-around-the-globe/countries/ken/en (Accessed: 05 June 2023).

Rosenberg, T. (2012) *In Rwanda, health care coverage that eludes the U.S.*, *The New York Times*. Available at: https://archive.nytimes.com/opinionator.blogs.nytimes.com/2012/07/03/rwandas-health-care-miracle (Accessed: 05 June 2023).