A STUDY OF FRUITING SEASONS AND YIELD OF BREADFRUIT
IN JAMAICA 2018-19
S. M. MCLAUGHLIN
DRAFT
JUNE 2019

CONTENTS:

I. INTRODUCTION

Trees That Feed Foundation's (TTFF) programs reduce hunger, create jobs and benefit the environment. TTFF aims to see Caribbean communities with a sustainable food supply, marketplace for food products and a reforested environment. Since its inception TTFF has distributed over 175,000 fruit trees suitable to the tropical environment in Jamaica, Haiti and other countries in the Caribbean, Central America and Africa.

Over half of the trees that are distributed by TTFF are breadfruit trees. Trees go mainly to smallholder farmers, but TTFF wishes to see a marketplace develop for breadfruit and value-added post-harvest products. To encourage development, better information is needed on the likely yield of breadfruit cultivation. While there is plenty of anecdotal evidence about breadfruit yield, there is little quantitative information. This report summarizes results from the first year of study in Jamaica.

II. GOALS OF THIS STUDY

In the absence of good data on yield, farmers, food processors and distributors are reluctant to invest in a breadfruit agribusiness. The economics are uncertain and the risks unacceptable. This project is intended to reduce the uncertainty and risk.

This study measured fruit count and other characteristics in several different locations in Jamaica over a 12 month period. At a minimum, a full year of study is necessary to identify seasonal variations in yield. We identified the average number of fruit that a single breadfruit tree might yield over a year.

A second equally important goal was to identify the peak bearing season. Anecdotal information about bearing dates in Jamaica varied widely, of course, there is likely local variation in peak bearing season due to different microclimates and soils.

Additional data were collected to try to study correlation of yield with other factors such as cultivar, rainfall, fertilization, soil conditions, elevation and more.

III. METHODOLOGY

The project started with a kickoff meeting at the College of Agriculture, Science & Education ("CASE"), with the assistance of senior lecturer Dr. Seymour Webster. At the meeting several locations in Jamaica with mature breadfruit trees were identified. The idea was to include several parts of the island to cover a range of microclimates. Practically speaking, most trees selected were in the parishes of Portland and St. Mary, both of which are considered good environments for breadfruit trees. Later studies may wish to include additional parishes.

Each tree was assigned a unique number, labeled, photographed and geotagged with exact latitude, longitude and elevation, as it was essential to track specific individual trees.

Teams of CASE students were identified to travel to the various locations. The students traveled to each of five initial locations (more locations were added shortly thereafter) every 2 weeks to count fruit. Clickers, soil pH meters, collection forms and clipboards were provided. Most student teams had camera-phones with GPS capability. TTFF obtained funding to pay a modest stipend to the students plus local travel expenses, to encourage participation for the full study period.

Data forms were collected and transmitted to TTFF headquarters in the Chicago, Illinois area where they were reviewed and entered into spreadsheets.

Other teams composed of citizen scientists were recruited to increase the number of trees in the study. One agronomist was hired at a modest stipend, and his work on six trees was exemplary.

It was originally hoped to identify 100 trees of at least three different varieties. Logistical difficulties prevented that from happening. In the end, 52 trees were included and of those the study has a full year of data for 45 trees.

In order to count accurately the student teams were instructed to divided the area around each designated tree into 4 quadrants, NE, SE, SW and NW. The teams counted male inflorescences, immature fruit, mature fruit on the tree, fruit seen on the ground, and fruit harvested and taken away. Mature fruit are those of full size with indications of latex oozing out of the skin. The idea was to compare the peak number of immature fruit on the tree and compare that with the total of mature, fallen and harvested fruit. The higher of these two numbers was assumed to be the maximum likely yield of mature fruit. As it happened in all cases except one we used the peak number of immature fruit,

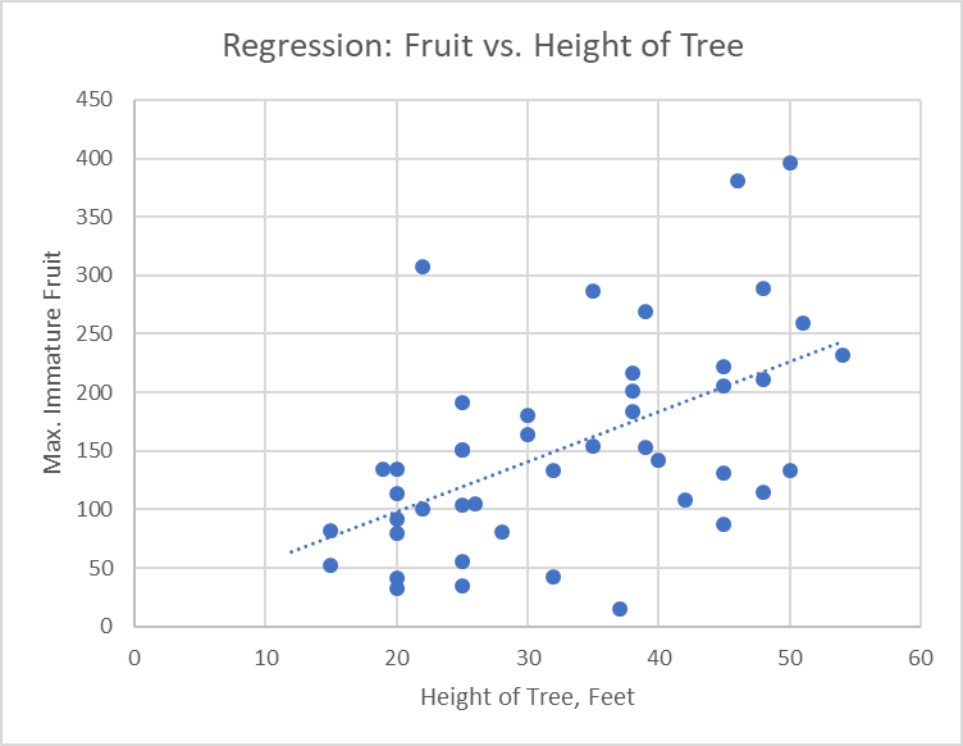
combining the two bearing seasons, because it was impossible to determine how many fruit had been harvested. For one tree, the number of fallen fruit was the maximum count by a small margin.

More detail on the protocol is included in the Appendix.

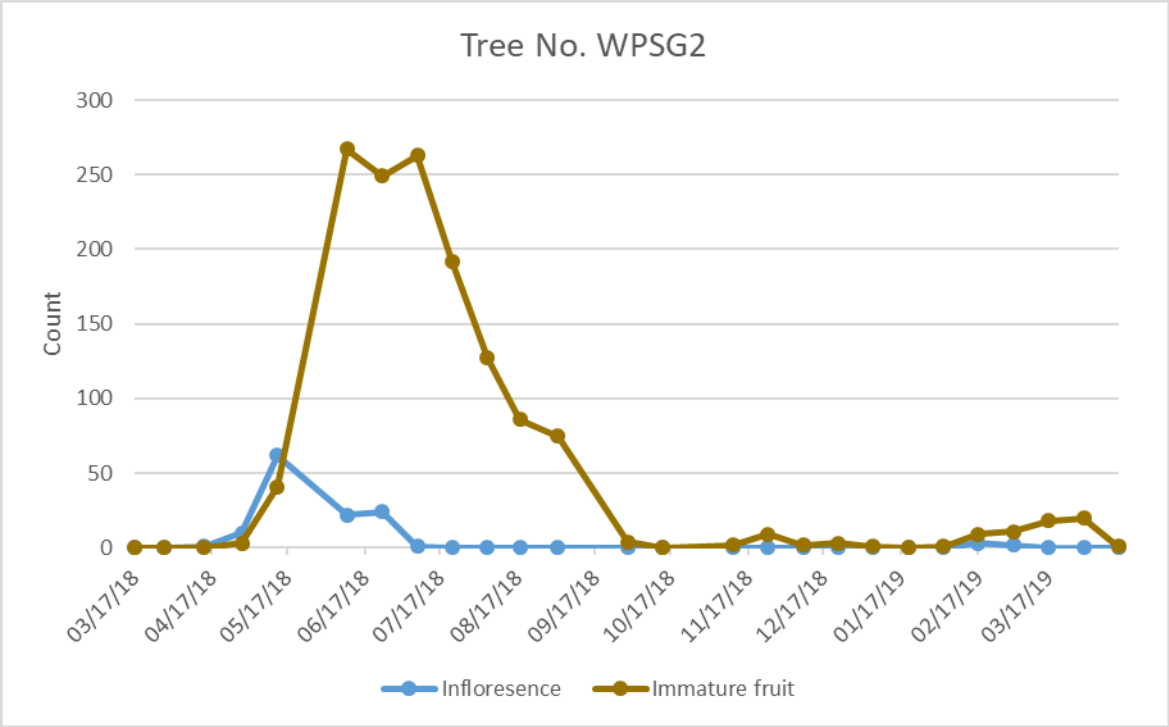
IV. RESULTS

The data collected seemed accurate and internally consistent. We had periodic field checks by our local TTFF representative. The student teams varied somewhat from time to time, but the data collection was consistent and reliable. We have confidence in the number counts that were recorded, however some data elements are incomplete.

As a rough validation of the data, we plotted the fruit count against the height of the tree. In general, we expected an increasing trend line (the taller the tree, the more fruit produced), and that is what we found.



As an example of results, here is the yield over the 26 or 27 bi-weekly observation periods for one specific breadfruit tree, numbered WPSG2. This tree is located on the Willis's property in Spring Garden district, Portland. Five trees on that property were included in this study.



The graph plots male inflorescences (blossoms) and immature fruit counted. The counts were taken at each observation date approximately 2 weeks apart. This particular tree could potentially produce up to 287 fruits at maturity. In practice, of course, some immature fruit fall off before ripening. We believe this is due mainly to lack of water. In this study we were looking for the maximum potential yield and haven't tried to quantify losses due to excess (or lack of) rain, wind, theft or any other cause.

Similar graphs can be prepared for the 45 trees with a full year of data.

The full data set used in this study will be made available on our website, https://treesthatfeed.org/breadfruit-yield-study.

The main findings of this study are summarized below.

1. The average of the maximum yield for all 45 trees in the study was 154.5 fruits. Standard deviation was 87.7. This number was somewhat smaller than what we had expected; we thought the average would be approximately 250 fruits per year. Below is a histogram showing the number of trees in each fruit count range.
2. The highest yield of any tree was 396. The lowest was 15, a tree noted as being completely in the shade of a larger tree. We would speculate that any tree producing less than about 50 fruit per year was experiencing serious problems, whether lack of sunlight, water or nutrition.
3. Six trees in the study were noted as being fertilized with organic material, for example kitchen peelings. For all other trees, no fertilizer of any kind was observed. The average

yield from those six fertilized trees was 264 fruits. The average yield of the other 39 trees was 138.

4. The main bearing season runs May-June-July-August, with a much smaller secondary season in February-March. Five of the 45 trees with full year data had a peak outside these four months (two in April, two in September, and one in October). A group of trees in the parish of St. Mary peaked somewhat later than the average, namely in early August. We believe the bearing season varies by a few weeks in other parishes but we don't have enough data to quantify.
5. The main bearing season occurs during the hotter months of the year rather than during or after the rainiest months.
6. The number of trees peaking in each month are as follows:

April	2
May	5
June	18
July	12
August	5
September	2
October	1
TOTAL	45

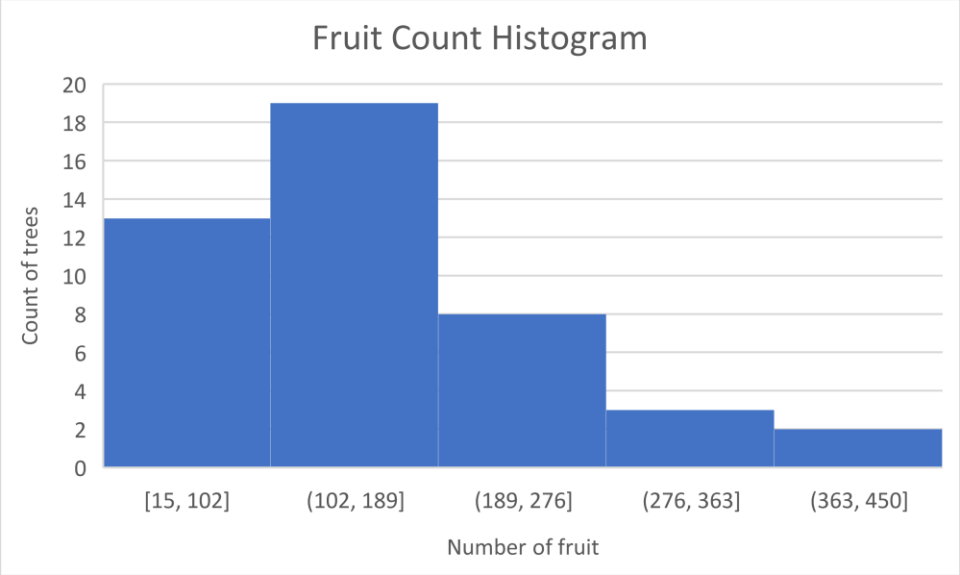
7. We looked at the number of fruits counted in each quadrant, and usually the NE quadrant had the most fruit. The total count is as follows:

NE	7,989	26.5%
SE	7,545	25.0
SW	7,632	25.3
NW	6,968	23.1
TOTAL	30,128	100.0%

   We can't explain this phenomenon, and we have not yet tested whether this is statistically significant.
8. For each tree we also identified the type of soil, slope of the terrain, other breadfruit trees nearby, height and circumference, age and the amount of sunlight exposure. Circumference was measured at 4 feet high. Of course this measure is approximate as tree trunks typically are not perfectly round. Perhaps more analysis is needed but we saw no clear correlation of any of those factors with yield (except as mentioned above, use of fertilizer).
9. For each data point we aimed to record whether or not there had been any rainfall since the prior observation, and soil moisture and pH. Unfortunately, we do not have a complete data set for these data points and are unable to draw any conclusions. We have requested additional data from Jamaica's Meteorological Department in case it provides further insight.
10. The average yield of the four Ma'afala trees was 78.5. Those trees are all about 7 years old, hence not fully mature.
11. The count of male inflorescences did not seem to be valuable with regard to being a good predictor of fruit yield. The fruit of breadfruit develop in the absence of pollination, so the

male inflorescences are not necessary for fruit development. However the timing of the peak of male inflorescences averaged 2.9 weeks prior to the peak of fruit.

The study revealed a few surprises, compared to prior anecdotal information. The average yield is less than we expected, however, the potential peak yield (if no fruit are lost) is similar to what we expected. We expected the main fruiting season would come after the heavy October rains, but that was not the case. We also expected that fertilizer would make little or no difference to yield, based on a prior field study, but that was not the case.



This report presents our main findings as of June 2019. We encourage readers to access the full dataset when it becomes available and report on additional (or supportive or contradictory) findings. We also anticipate that other researchers may probe further as we gather more data.

V. CHALLENGES AND OPPORTUNITIES FOR FURTHER STUDY

There were a number of practical challenges encountered during the course of this study. Early on we received illegible forms, where we couldn't distinguish between the numerals 1, 2 and 7, as they had been hastily scribbled. The teams initially went out weekly at a time when there were few or no fruit on most trees. This represented a potential budget concern. Within a few weeks however we clarified the numbers and better organized the teams to control expense.

Part way through the study one tree was cut down by the utility company clearing overhead wires. One other tree was pruned. These two trees were excluded from the study.

We have some anecdotal experience that pruning a breadfruit tree is helpful for long term fruit production. The tree stays shorter, hence the fruit are easier to reap, and in fact the yield seems to bounce back to at least the level prior to pruning. We did not perform any formal study to test this.

We were unable to gather sufficient data in parishes other than Portland and St. Mary to reach any conclusions as to how the peak bearing season varied from place to place in Jamaica. Anecdotally, we have heard that fruit were coming in 4 weeks earlier in the parish of St. Thomas, but that is unverified. This would be a good area for further study.

We were unable to reliably compare fruit yield for different varieties of trees. Of the 45 trees included in this study, 31 were identified as yellowheart which is the most common and most preferred variety in Jamaica. Six trees were identified as Ma'afala (a recently imported variety), Timor or Whiteheart. These small numbers did not provide the opportunity to really test variation across varieties.

We have requested rainfall data for the study period in the areas where the study trees are growing. We'll compare actual precipitation numbers with the traditional May and October rainy seasons to verify.

VI. ACKNOWLEDGMENTS

TTFF wishes to thank Conservation, Food & Health Foundation, Boston, for a generous grant that funded this study. In fact, CFHF agreed to extend the grant to permit a second year of study which is under way as of this writing.

We also wish to thank Dr. Seymour Webster, Lecturer at CASE, the College of Agriculture, Science & Education, in Portland, Jamaica. Dr. Webster not only provided great advice to the project, but he also managed the student teams. Due to the academic calendar there was some rotation and additional training for new team members from time to time. He also carefully managed the budget for stipends and travel.

CASE gave permission for study of trees on its property, as did Mr Trevor Willis and Ashley Christie. We thank them for their cooperation.

Miss Sukkasini Thissaverasinghan, CASE staff member, was very helpful in organizing and transmitting the data sheets from the student teams. Miss Singh helped substantially in maintaining the accuracy of the data collected.

Mr Syran Stewart, Agronomist, collected data on six trees for the entire 12 month study period. His data were accurate and consistent, and he suggested methods for tracking cumulative counts of fruit fallen or taken away.

Mr Joseph Johnson, TTFF representative in Jamaica, managed the teams in the parish of St. Mary and also served as field supervisor on the student teams.

The initial draft of protocol for the study was greatly aided by advice from Dr. Noa Lincoln, of the University of Hawaii. He was developing a related study in Hawaii.

Mr. Clive Forest was an outstanding Citizen Scientist team member.

Dr. Nyree Zerega, TTFF Board member, provided advice and consultation on the project.

Ms. Judy Osgood, TTFF volunteer, served as data entry and validation clerk.

S. Michael McLaughlin, TTFF Secretary-Treasurer, author of this paper, led the study.

VII. APPENDIXES

a. Data Collection form—Trees
b. Data Collection form—fruit
c. Data Collection instructions
d. CASE Student Team Members
e. Photos
f. About Trees That Feed Foundation

Appendix A
Tree Data Collection Form:
BreadfruitYieldSurveyFormTree.pdf

TREES THAT FEED FOUNDATION BREADFRUIT YIELD SURVEY TREE FORM	
Team:	
Name of surveyor	
Date	
Unique Tree Number	
Variety (if not known, describe)	
Location (name)	
Location (street directions)	
GPS: Latitude	
GPS: Longitude	
Elevation	
Soil Type	
Slope of land	
Distance to nearest breadfruit tree	
Height of tree	
Circumference at chest height	
Age of tree	
Sunlight exposure	
Physically tagged?	
Indicated North, E, S, W directions?	
Other notes:	

BreadfruitYieldSurveyForm.xlsx

Appendix B
Fruit Data Collection Form:
BreadfruitYieldSurveyForm.pdf

TREES THAT FEED FOUNDATION
BREADFRUIT YIELD SURVEY 2018

FRUIT COUNT DATA FORM

Use this form to record fruit count every 2 weeks

Team:	Citizen Scientist				
Name of Surveyor					
Date					
Unique Tree Number					
Quadrant:	NE	SE	SW	NW	TOTAL
	Number observed at each stage:				
Male infloresence					
Immature fruit					
Mature/Ripe/Fit fruit					
Fallen to ground					
Harvested/taken away					
Rainfall last 2 weeks:					
Fertilizer last 2 weeks?					
Weight of 3 samples of full size fit/ripe fruit (grams)					
Other notes					

C:\Users\S Michael McLaughlin\Dropbox\TTFF\COUNTRY FILES\Jamaica\2018 Yield Study CFHF\BreadfruitYieldSurveyForm

Appendix C
Data Collection Instructions (for Citizen Scientists)

Hello, Citizen Scientists!

Welcome! Thanks for volunteering to join our team! Trees That Feed Foundation appreciates your help in this important study about breadfruit yield. We are measuring quantity and seasonality of fruit bearing.

Here are our easy-to-follow instructions.

Get Prepared:
Read these instructions and review the attached files. There are two data forms and an optional log form to track dates of observation.

- Print out one copy of the Tree Data Form, one copy of the optional Log Form, and 26 or 28 copies of the Fruit Data Form. Keep them together in a folder.
- If you have a camera or smartphone, check if it has built in GPS and if so, turn on that feature.

Remember to check your email every 2 or 3 days throughout this one-year long project.

Tree Instructions:
Basically you only have to do this once:

- Identify the tree that you'll be monitoring for the next 12 months. (We may assign a number to your tree, in which case, put that number on your recording sheet.) Tie a ribbon or spray paint it with a smiley face. That will jog your memory to count the fruit every 2 weeks.
- It's best if you pick a tree that you can observe from all sides. You will need to count fruit on all sides.
- Record the location as accurately as you can (street address and/or GPS latitude and longitude).
- Very briefly describe the soil type … loam, sand, clay, …
- Tell us the variety or type of fruit, if you know.
- Take 2 or 3 photos of the tree, one far away, one close up of the leaves, a picture of a mature fruit, if possible.

Fill out the Tree Data Form as completely as you can. Don't worry if you don't have all the information. OK to use your best estimate. Take a nice clear picture of the tree form and send it to us by email or WhatsApp, or Fax the form.

Fruit Counting Instructions:
Do these steps, start now, every 2 weeks.

- Count the fruit that you can see, from four different points of the compass, preferably NorthEast, SouthEast, SouthWest, NorthWest.
- Count mature and immature fruit on the tree. Count them all, every time. It's OK if these are counted more than once. We know that the fruit take a long time to ripen on the tree.
- Count fruit actually picked or fallen to the ground (don't double count those—remove them away so they don't get counted twice).
- Weigh a sample of the fruit if you can, not just the biggest ones but the average size. Don't weigh all, just a few.
- Record any rainfall in the last 2 weeks (since the last observation); we know you don't have a rain gauge, so just estimate or describe.
- Record if any fertilizer was used.

Easiest way to report, probably, just take a clear picture of your Fruit Data Form and email, WhatsApp of Fax to us. Email to info@treesthatfeed.or and WhatsApp to me, 1.312.315.0955, or to the group "Citizen Scientists 2018."

Parting words:

Now remember, this project will continue for one year! Check your tree every 2 weeks (if you're off by a day or two, no problem) and send in your report right away. Use the forms provided that way our data is all consistent.

Any questions, don't hesitate, contact me any time.

Thanks!

Citizen Scientists Instructions.pdf

Appendix D

Our thanks go to our CASE Student team members:

- T. Alexander
- Omelia Barrett
- F. Burrell
- Julius Delano
- Kimone Forrest
- Desmon Gordon
- E. Harrison
- K. Hyman
- K. Martin
- C. Rose
- D Rumble
- D Sanderson
- ? Sayle
- K. Scafe
- Jevaun Spence
- Rudane Walcolm
- A. Walker
- Austin Watson
- L. Whorms
- M. Wilson

Our apologies to any inadvertently omitted.

Appendix E
PHOTOS

Photo of Tree number JF1.1
IMG_0245.jpg
Lat. 18-17-47.802
Long. -77-0-13.176
Elev. 397.6 m

Appendix F
About Trees That Feed Foundation:

TTFF plants fruit trees in 17 countries: Haiti, Jamaica, Antigua, The Bahamas, Barbados, Costa Rica, Dominica, Puerto Rico, St. Vincent, Suriname, Ghana, Kenya, Liberia, Pakistan, Tanzania, Uganda, and U.S. Virgin Islands. We donate breadfruit trees, mango trees, avocados, cashews, and many others. **Our vision is seeing self-sustaining communities** and entrepreneurs, based on agroforestry.

For more information visit https://treesthatfeed.org/about-us