Food Production Research

Research on productivity and inputs for cultivation

2022-2025

Project Report October 2022

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Outline

1. Name of the project: AuroOrchard Production Research

2. Name of the project holder(s): Anshul Aggarwal

3. Project team: AuroOrchard team, Giulio (CSR - Auroville Centre for Scientific Research), Azhaganandan (Taalam), Sowmya Komaravolu (Data analysis)

4. Amount received in rupees from SDZ: Rs. 3.46,062

5. Year in which grant received: 2022

6. Amount(s) received from other donors: Rs. 0

7. Aims & objectives of project:

(i) Collect data of productivity by season and by location on the farm

(ii) Collect data on water consumption by location and crop

(iii) Collect data on overall production cost

(iv) Analyse production data to compare productivity by season and compare productivity by area to analyse how different inputs and management techniques impact production

(v) Analyse differences between production and sales quantities reflecting loss to damage due to pests, harvesting practices (time and technique). This would help in planning for such losses and build resilience.

(vi) Compare production value with water consumption and calculate water consumption/unit production

(vii) Compare production value with expenses and calculate cost/unit production for different areas and crops

(viii) Sharing this information within the farm and with other farms in Auroville for better planning and developing and sharing practices for optimum production and resource management.

(ix) Sharing this information within Auroville to better understand the resources required to grow food for the community and contribute to the conversation on food security.

(x) Sharing this information with farms and communities outside of Auroville demonstrating a system for measurement and analysis for a farm developed from scratch.

Project progress

S.no.	Planned goals	Timeline	Status
1.	Creation of team	2021	We had a project manager who left in August 2022. But we are training more people on the farm to help with data collection. Analysis is more specialised and currently only one person is handling it supported by volunteers.
2.	Set up a production measurement and analysis system	By April 2022	This is done. We were able to pilot a system between September 2021-March 2022 for testing and made required improvements. The current system works well and is being used every day.
3.	Set up a distribution measurement and analysis system	2022	The distribution (sales) measurement system was already in place. We are working on integrating it with the production system so that production and distribution values can be compared. We anticipate this to be done by March 2023.
4.	Numbering/tagging of production areas	2022	Done.
5.	Budget and funding	2021	We are not looking for more funds at the moment. The idea is to implement this system for a couple of years and see how best we can use it.
6.	Analysis and Reporting		The project holder is doing regular analysis and reporting to the team.
7.	Water research, installing water meters	2023	This has been done sooner than we anticipated. We now have the required water metres and will start monitoring water consumption from 2023.
8.	Recording and categorising expenses	2024	We have recently made headway with this. We now have a simple system to record and categorise all our expenses. We will keep testing this system for this year and train more people on the farm to use this so that we can develop a strong data foundation for further analysis.

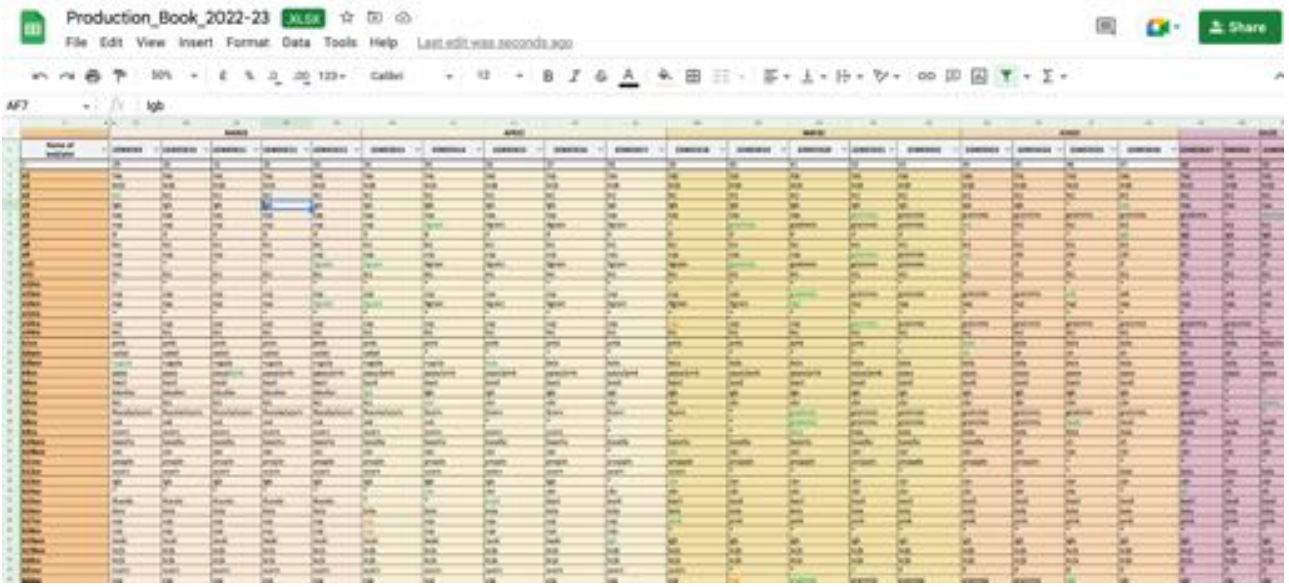
Project accounts

Link to google sheet

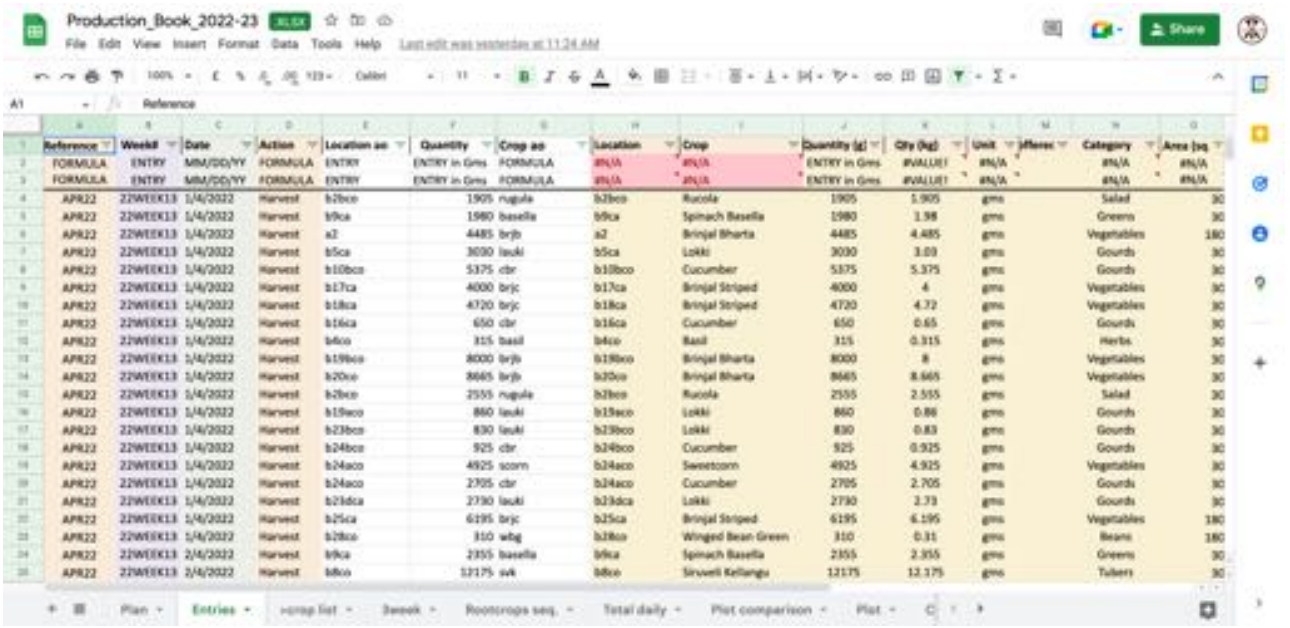
	#	Date	Budget Heading and Items	Amount received/ spent	Comments	Balance INR	Balance Euro 1€ = 80 INR	Balance USD 1$ = 75 INR
	1	7/5/22	Grant from PCG	385501	Grant approved for phase 1 and 2	385501	4819	5140
	2	7/5/22	SBI Charges	-988		384513	4806	5127
	3	7/5/22	Auroville Overhead & Administration (10%)	-38451		346062	4326	4614
Phase 1	4	09/06/22	Water meters	-135362.19	3 water meters for bore wells.includes 3 years extra warranty and GST. Each meter costs 36966.72 plus 18% GST, i.e. 43620.73 each, **plus 4500 shipment fee.**	210700	2634	2809
	5	09/06/22	Micrometers for beds/plots	-31084.03	ONLY BOUGHT 4 pieces so far (out of 10 planned) includes 3 years extra warranty and GST. Each meter costs 6585.6 plus 18% GST, i.e. 7771.01 each.	179616	2245	2395
	6	06/09/22	Plumbing costs	-35887	Meter wise details here: https://docs.google.com/spreadsheets/d/14vHea4V2Nmd-zFgndAdN_4MgVzhgRbnyUCYucWsS7WU/edit?pli=1#gid=852558050	143729	1797	1916
	7	13/05/22	Plot/Bed markers	-3000	Completed	140729	1759	1876
	8	04/06/22	Desktop Computer	-30750	This has been a huge help in increasing the capacity of work on this project.	109979	1375	1466
	9		Weighing scale	0	Pending purchase.	143729	1797	1916
	10		Office Desk	0	Pending purchase. may not be necessary.	109979	1375	1466
	11		Paper, printing, stationery costs	0	Pending purchase.	109979	1375	1466
Phase 2	12		Additional water meters	0	Next phase	109979	1375	1466
	13		Other measurement equipment	0	Next phase	109979	1375	1466

1. Production Data Recording System

This is an Microsoft Excel based system developed at AuroOrchard. So any technical errors or updates are easily fixed. Also, it is easy to train new team members to work with this system. After several months of testing and improvements, the current system works really well.
The system also helps in regular planning for crops and giving a snapshot of what is growing where.



A snapshot of the planning sheet in the Production Book



A snapshot of the data entry sheet in the Production Book

2. Mapping of growing areas

To be able to record production, it is important to tag different growing areas so that production corresponding to them can be recorded separately. This helps in assessing why some areas could be more productive or better suited for a certain crop. Eventually this helps in sharing scientific conclusions on what can be grown on the farm and in Auroville and with what amount of resources.

Geo mapping of the areas was done to get an accurate picture of our main growing areas. These areas have also been labelled by stone markers and each has a separate code which is used while entering any production from these areas. These codes will also be used when measuring water consumption of these areas and eventually inputs to calculate production costs.

Geo-mapping done by the team from
Auroville Center for Scientific and Research (CSR), Auroville

Ishan fixing stones along all the beds and plots

Painting the stone markers


A1


A1


A4


A9

Stone markers after installation and numberning

RESEARCH ON WATER CONSUMPTION

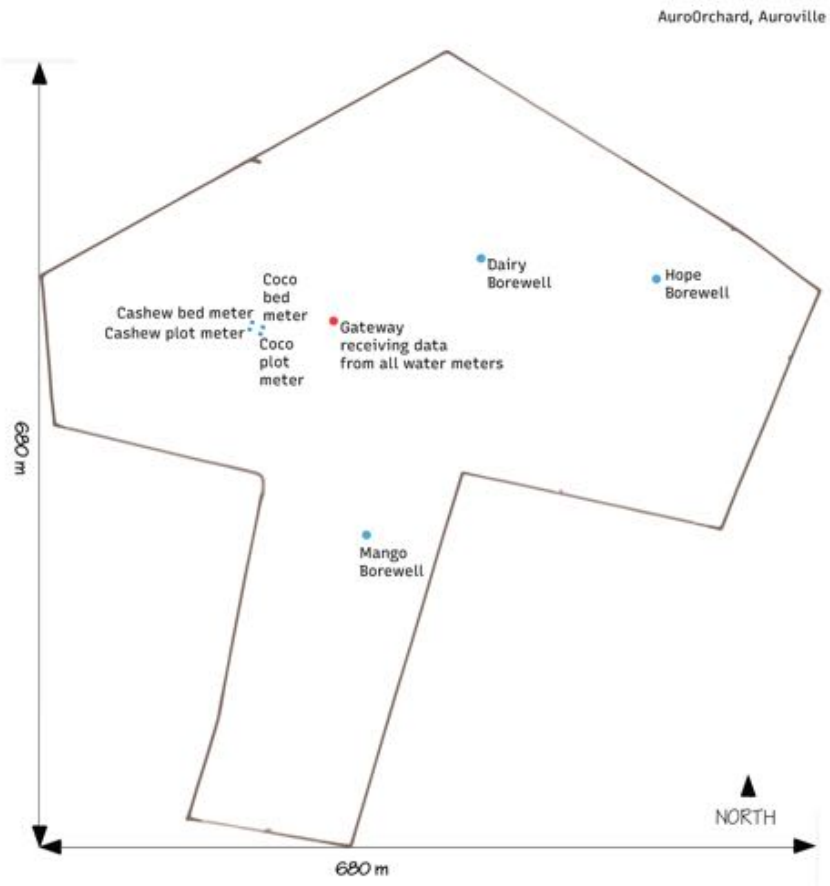
1. Water meter installation

The work with the water meters is being done closely in collaboration with the Auroville Center for Scientific Research (CSR), Auroville. Giulio, a member of CSR and Auroville Water Group is helping us with this.
We also have the support of Taalam for technical assistance. Azhaganandan (Azha) from Taalam has been working with us on this project. We have been meeting regularly since September 2021 (once every 2 weeks) to discuss, plan, design and test.

We decided to install water meters at 7 critical locations:

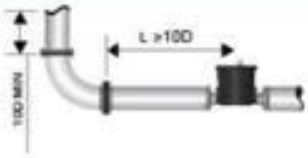
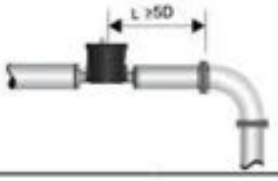
1. At the 3 borewells serving the entire water needs of the farm namely Hope, Dairy, Mango
2. At 2 beds and 2 plots in the vegetable growing area to measure specific consumption on a growing area and deduce production per litre of water.

The meter installation was done with the help of a specialised plumber who has experience with installing water meters in Auroville.
Full meter wise installation cost can be accessed here.

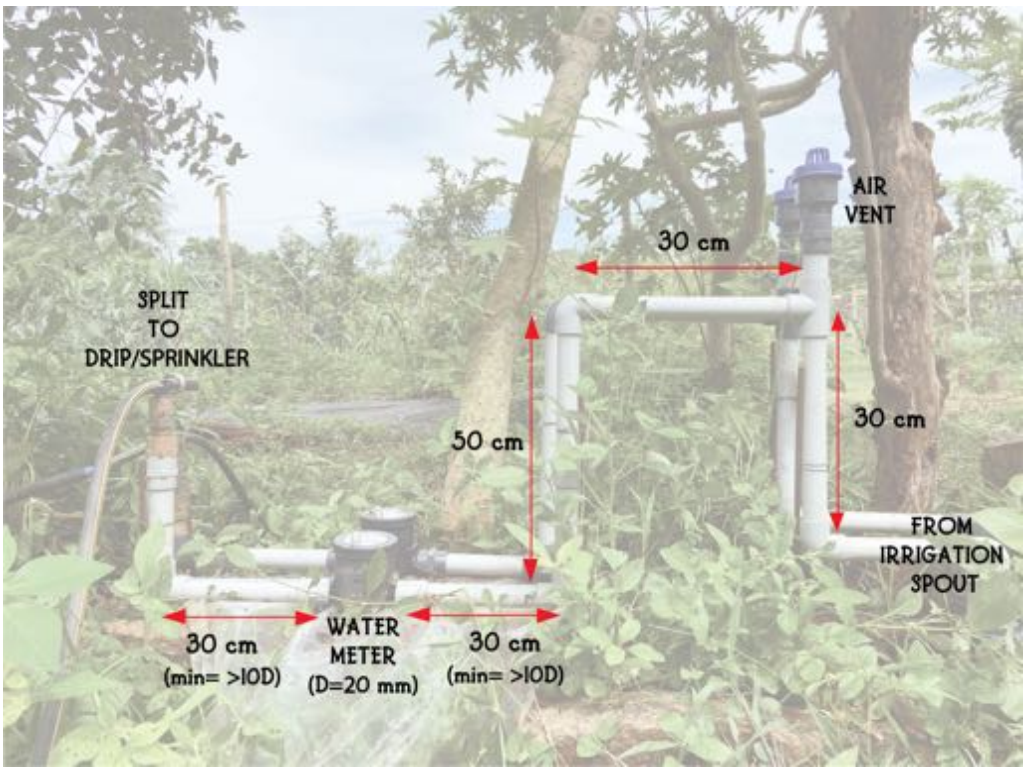


Approximate locations of the water meters installed

Water meter installed at Hope Borewell

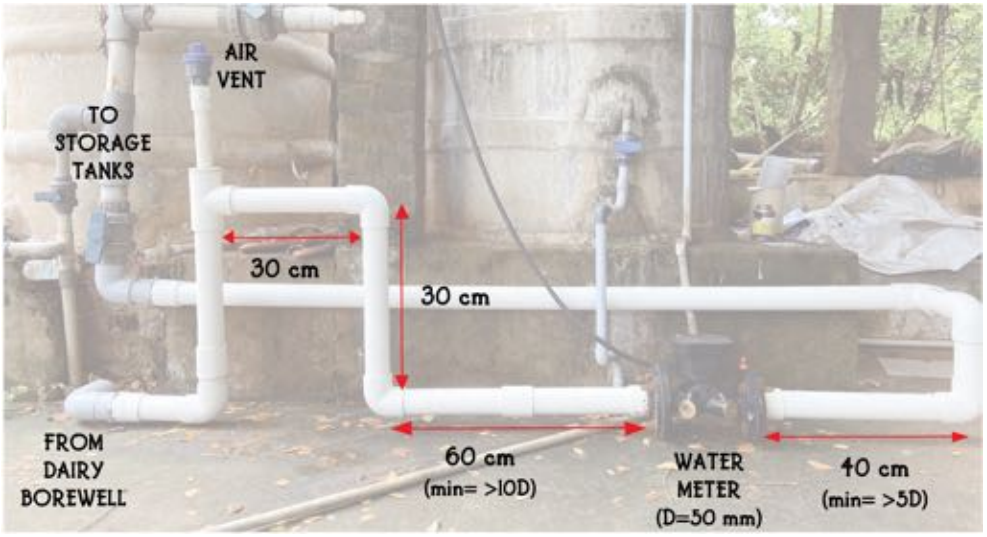
NAME	STRAIGHT LENGHT OF UPSTREAM PIPING	STRAIGHT LENGHT OF DOWNLSTREAM PIPING
90° BEND		
TEE		

Guidelines for installation provided by the meter manufacturer
Detailed installation guidelines are available here

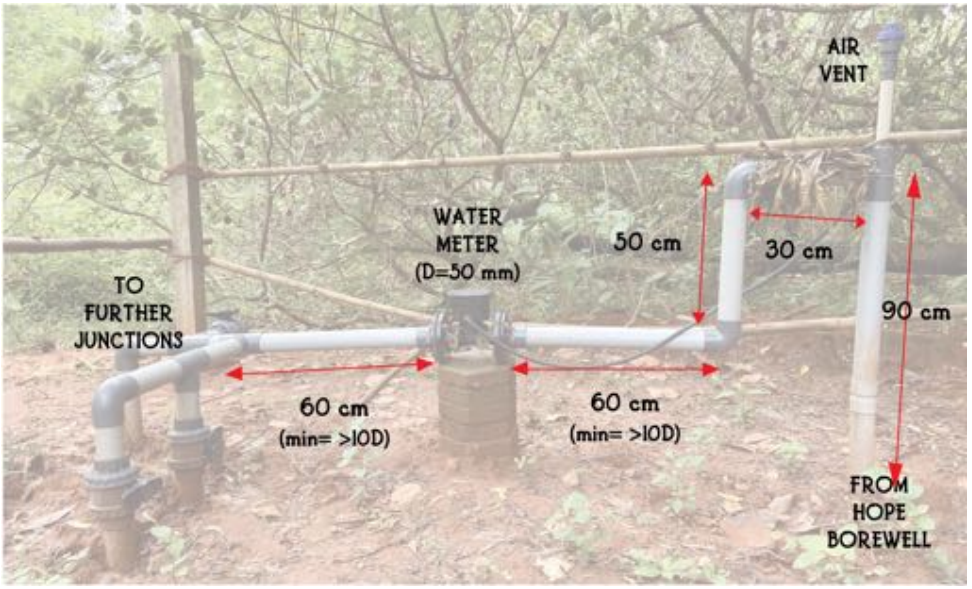


20 mm water meter installed on cashew side of Zone B

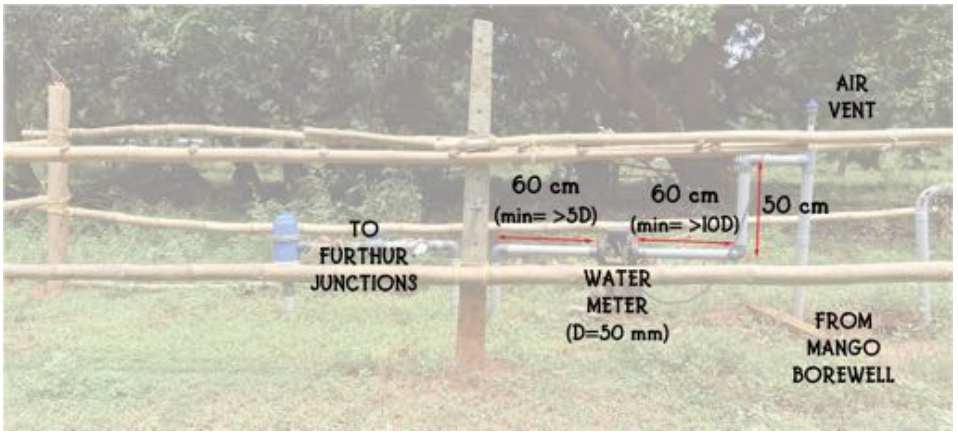
20 mm water meter installed on coconut side of Zone B



50 mm Water meter installed on Dairy Borewell

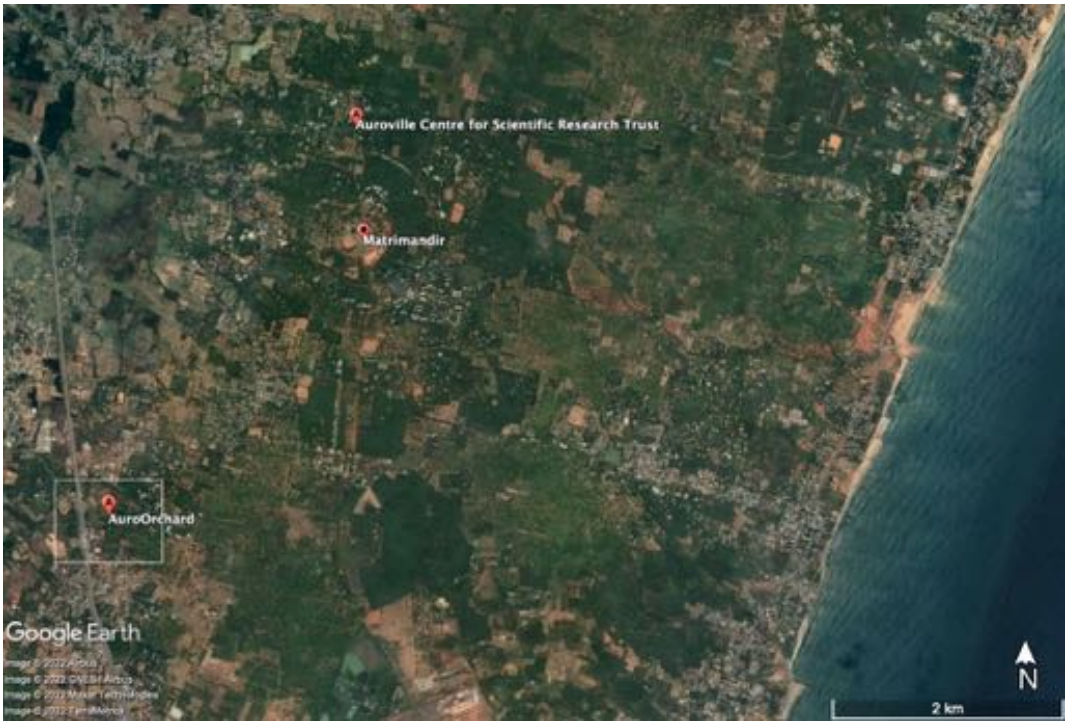


50 mm water meter installed on Hope borewell



50 mm water meter installed on Mango borewell

Once the meters were installed, we needed to check how well the data from the meters can be transmitted and received. The initial idea was to use a receiving gateway at Auroville CSR which is situated about 4 kilometers north-east of AuroOrchard.
During the testing, data loss from the meters was observed. After several iterations, it was decided to install a receiving gateway at AuroOrchard itself.



Location of AuroOrchard in relation to CSR, Auroville

Azhaganandan (Azha) testing for signal transmitted by water meters

2. Radiation measurement

There are multiple ways (manual checking of readings, transmission over wifi, or data storage in a USB, transmission through SIM card and transmission through LoraWan) in which the water meters can transmit the data. Considering the need for reducing manual work, we decided to have digital and wireless transmission for the water consumption data. One of the most efficient ways for wireless transmission is through Lorawan technology. Lorawan stands for Low Radiation Wide Area Network. The Lorawan transmitters and receivers work on a frequency range of 800-900 Mhz, a very low frequency range which allows them to transmit signals over large distances.
We had concerns of installing a gateway on the farm and its possible impact on birds, bees and humans. We invited Rene Janssen, a building biology consultant in Auroville, to measure the radiation emission from the lorawan gateway and water meters and give his insights on the impact from them.

Rene and Azha testing for transmission and radiation emission

Rene's main area of work concerns the quality of the indoor climate looking closely at air quality (Composition, pollutants, temperature and humidity), biological pollutants (moulds, yeasts, bacteria etc.), light, noise, radioactivity and other causes of indoor pollution. Though the work for Auro orchard is not indoors, he is still very interested to see the scope of influence and impact of Electromagnetic frequencies on the health of plants and animals, birds and insects and of course humans. Many farms are opting for smart systems which require a transmission and receiver channel running over the internet, lorawan or mobile network. However, there are very little studies on the long term health impacts of these technologies.

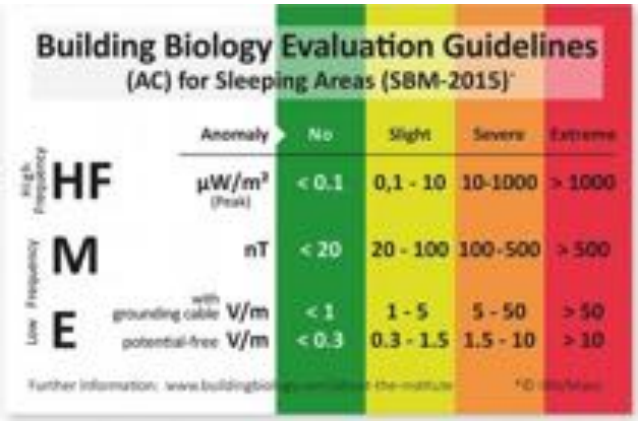
Before starting we discussed the scope of the measurement and how the values need to be interpreted. Rene shared that It is difficult to put a precise number on the radiation as there are several factors:

1. Distance from the emitter (both vertical and horizontal)
2. How often the signal is transmitted
3. Structures/trees/plants in between the emitter and the receiver
4. For how long someone is in the range of emission

Therefore the radiation measurement should be seen as a general value considering all these and the goal should be to minimise the impact especially when people are resting/sleeping for a long time.

These were the average values observed:

#	Device	Approximate distance of measurement		Radiation value observed	Evaluation
		Vertical	Horizontal	(micro Watts/sq.m.)	
1	Lorawan gateway	3 m	2 m	10,000	*This value is high but it is unlikely that people spend much time at this location.*
2	Lorawan gateway	12 m	10 m	20	*Acceptable level during normal day activity.*
3	Lorawan gateway	12 m	50 m	20	*Acceptable level during normal day activity.*
4	Office Wifi	0	0.5 m	16,000	*According to specifications the Lorawan Gateway is a little more powerful than a regular WiFi Router.*
5	Office Wifi	0	5 m	200	*A little increase of distance makes a big difference*
6	Water meter	0	1 m	3	*The radiation from the water meter is very low, there will be no concern for humans. However, it would be interesting to test if the water itself is influenced, which may have effects on the plants.*



This evaluation guideline from the Building Biology Institute to be used as a reference for sleeping areas.

<u>Conclusion</u>

In the current situation, there doesn't seem to be any reason for concern. But this may change in the future, the amount of EMF has been increased by thousands of times in the last few decades, this will only continue in the years to come. With 5G and the *Internet of Things,* we will be surrounded by transmitters. It is this accumulation that we should be concerned about. Although much is known about health effects, much more is still unknown. Even less is known when considering plants and animals. After all, all living beings on earth are electric beings, what will be the effects of artificial EMFs on them?

Therefore, we should be cautious in implementing any Radio Frequency (RF) devices.

3. Data Measurement

At the moment, data from 3 borewell meters is being received.
We checked the reading ourselves at certain times of the day in these meters and then checked the reading transmitted. These were found to correspond with each other.

Testing is going on for the other meters.
The data can be viewed here: *Water-meter data dashboard*
Based on this data, we will analyse daily consumption here: *Consumption analysis*

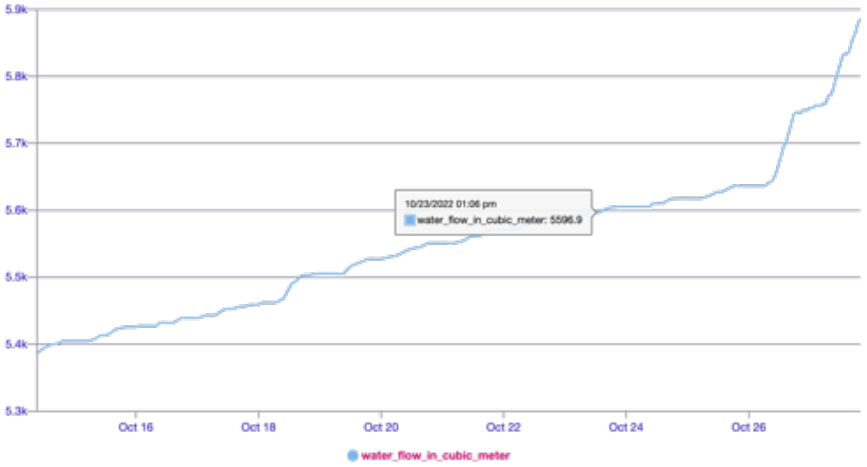


***Fig. 1**: Water meter data for Dairy borewell*

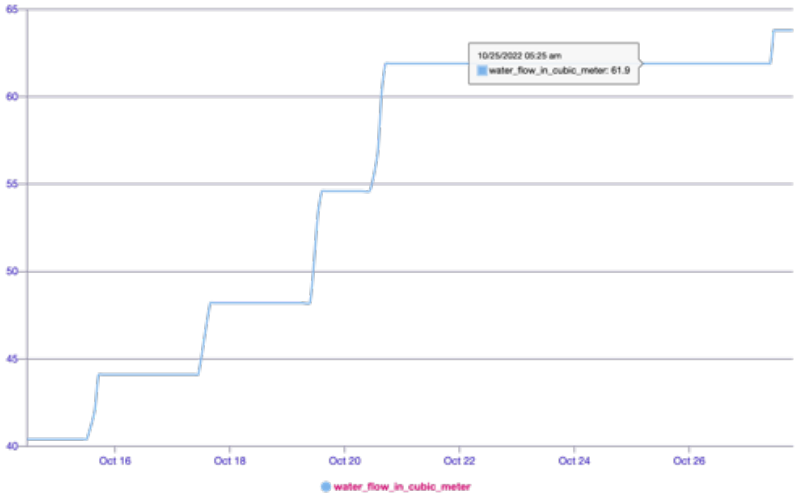


***Fig. 2**: Water meter data for Mango borewell*

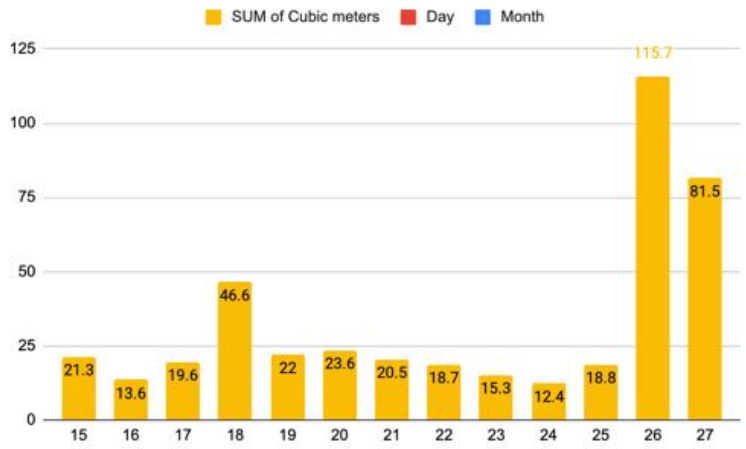


***Fig. 3**: Daily consumption analysis for Dairy borewell from Oct 15 to Oct 27, 2022*

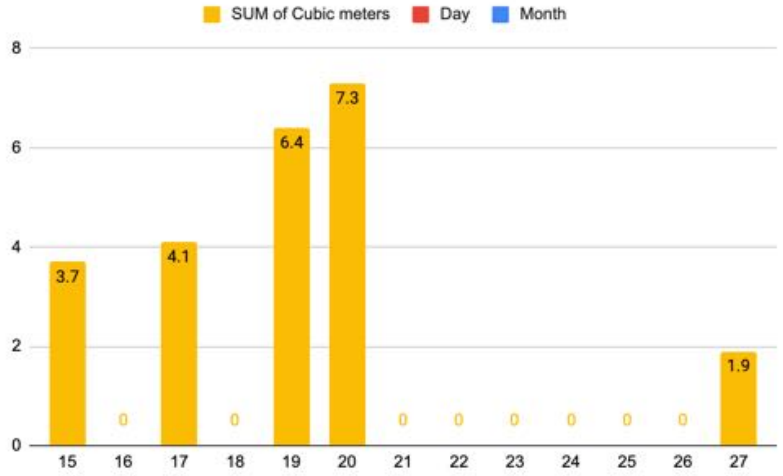


***Fig. 4**: Daily consumption analysis for Mango borewell from Oct 15 to Oct 27, 2022*

PRELIMINARY ANALYSIS OF PRODUCTION DATA

1. Comparison of Cucumber production on two raised beds (April 2022- June 2022)

Crop	Cucumber				
Sum of quar				Location	
REFEREN	Date	Action	Unit	b14co	b6co
Apr-22	07/04/22	START	gms	50	50
May-22	05/05/22	Harvest	gms		1545
	12/05/22	Harvest	gms		335
	19/05/22	Harvest	gms	805	
	20/05/22	Harvest	gms	605	
	21/05/22	Harvest	gms	230	
	23/05/22	Harvest	gms	1905	575
	24/05/22	Harvest	gms	845	515
	25/05/22	Harvest	gms	1085	
	26/05/22	Harvest	gms	2080	410
	27/05/22	Harvest	gms	2455	1900
	28/05/22	Harvest	gms	3065	2235
	30/05/22	Harvest	gms	2525	2335
	31/05/22	Harvest	gms	1455	1730
Jun-22	01/06/22	Harvest	gms	2210	1980
	02/06/22	Harvest	gms	1970	2955
	03/06/22	Harvest	gms	1950	2140
	04/06/22	Harvest	gms	1715	1005
	06/06/22	Harvest	gms	3955	2990
	07/06/22	Harvest	gms	1515	2895
	08/06/22	Harvest	gms	620	3490
	09/06/22	Harvest	gms	670	2535
	10/06/22	Harvest	gms	255	1670
	11/06/22	Harvest	gms	515	1900
	13/06/22	Harvest	gms	1355	3785
	14/06/22	Harvest	gms		3220
	16/06/22	Harvest	gms		1535
	17/06/22	Harvest	gms		1155
	18/06/22	Harvest	gms		1190
	20/06/22	Harvest	gms		3885
	21/06/22	Harvest	gms		1030
	22/06/22	Harvest	gms		100
	27/06/22	Harvest	gms		1355
Grand Total				**33835**	**52445**

Image from the analysis sheet

Bed name	**B6co**	**B14co**
Width	80 cm	80 cm
Length	30 m	30 m
Total area	24 sq. m	24 sq. m.
Number of plants planted	50	50
Plants survived	Not counted	Not counted
Total production recorded	52.45 kg	33.84 kg
Production per sq. m.	2.19 kg/sq. m.	1.41 kg/ sq. m.

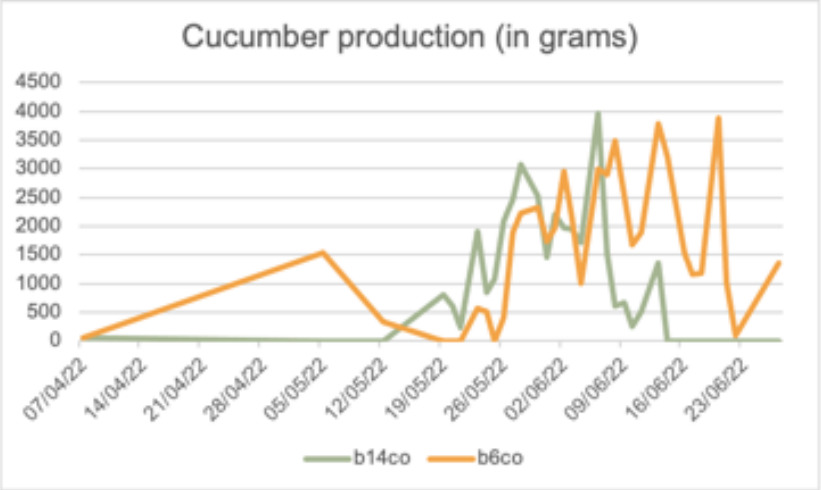


Fig 5: *Weekly trend of production (Kgs) for Cucumber*

Observations:

1. Almost all factors- time of planting, season, water, soil are same for both these beds.
2. When planting is done, typically some plants don't survive the transplant shocks, or if there are pests they would attack the vulnerable plants and we would lose some plants within the first 1-2 weeks of planting. Therefore production variation could also be attributed to the number of plants surviving after planting which may vary from plot to plot and season to season. Since the number of surviving plants was not counted, it is difficult to comment on the difference of productivity.
3. For this data to make sense, the number of fruiting plants (plants that are producing) in a plot/bed needs to be documented and compared with the number of another plot/bed of the same crop. We are organising how to do this regularly from now on. Excellent

2. Total production trends of 6 crops from April-September

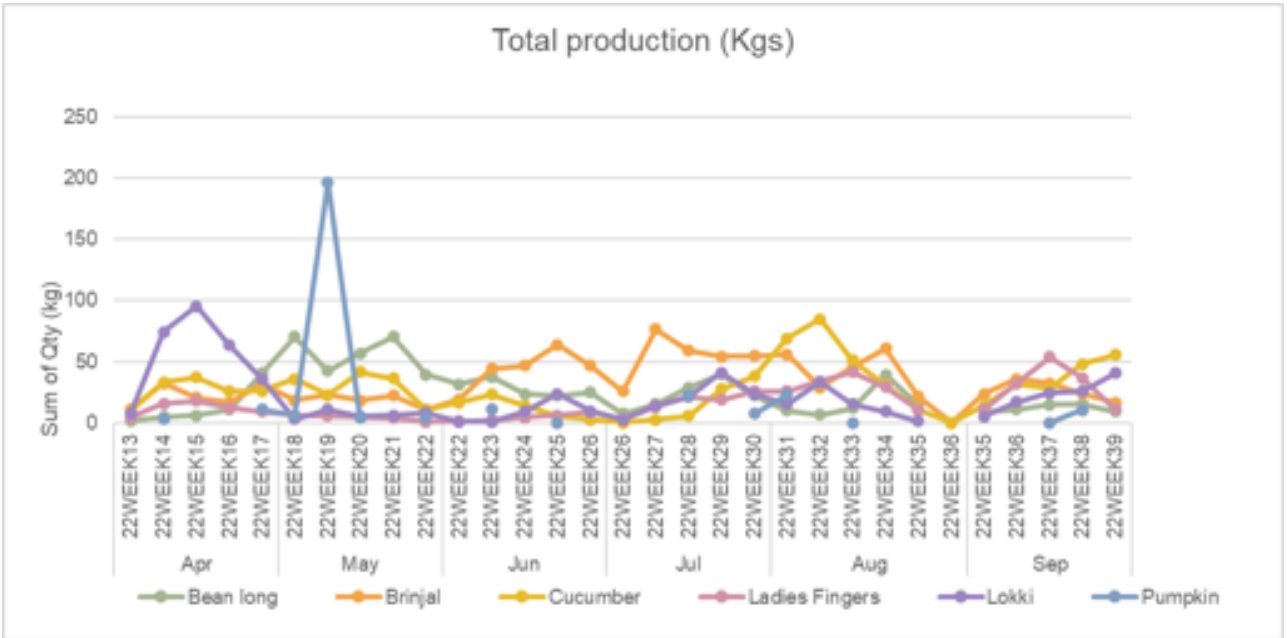


Fig 6: *Weekly trend of production (Kgs) of 6 vegetables*

Bean Long, Brinjal, Cucumber, Ladies finger, Lokki, Pumpkin

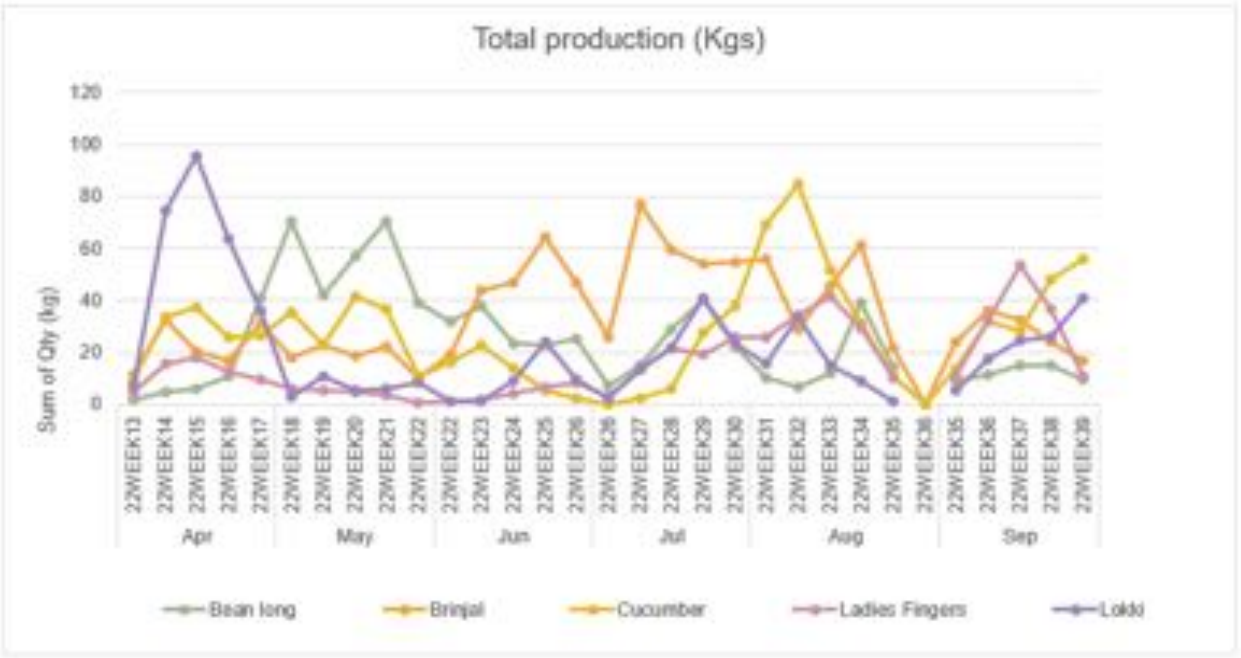


Fig 7: *Weekly trend of production (Kgs) of 5 vegetables (without Pumpkin)*
Bean Long, Brinjal, Cucumber, Ladies finger, Lokki

Observations:

1. The variation in production can be due to several reasons namely- the season, the number of plants planted, the number of plants that survived after each planting, pest attacks causing damage etc. It is difficult to relate the difference in production directly to any particular variable.
2. The peak of production in Pumpkin in early May is due to a single harvest of pumpkin during that time. These plants were planted in January/February and left without harvesting until May.
3. Pumpkin harvest in general is erratic. While all other crops are harvested at least 3 times a week, pumpkin harvest can have gaps as long as 2 weeks due to the time a pumpkin fruit takes to form and ripen. This also leads to less regular checking which often leads to sudden peaks in harvest and wastage as some fruits are over ripe by the time they are harvested.
4. April-May and July-August seem to be the good seasons for Long beans, Lauki and Cucumber.
5. There is a dip in production for most crops in early July. This is due to the impact of summer heat in May-June. Post this dip, the production is seen to improve for all crops due to rains and relief from excess heat.
6. There is a huge drop for all crops at the end of August. The plants which would produce during this time would be planted during July. Pest issues could be a reason. This will need to be seen next year and documented better.
7. Since the size of the area planted (either a bed or a plot) could be different at different times, production per area would give a better understanding of the productivity of the crop. We will also come up with figures on productivity per plant once the plants survived are being counted.

3. Productivity (production/square meters) analysis of Top crops

Comparing Kg produced per square meter (sq. m.) harvested for key crops

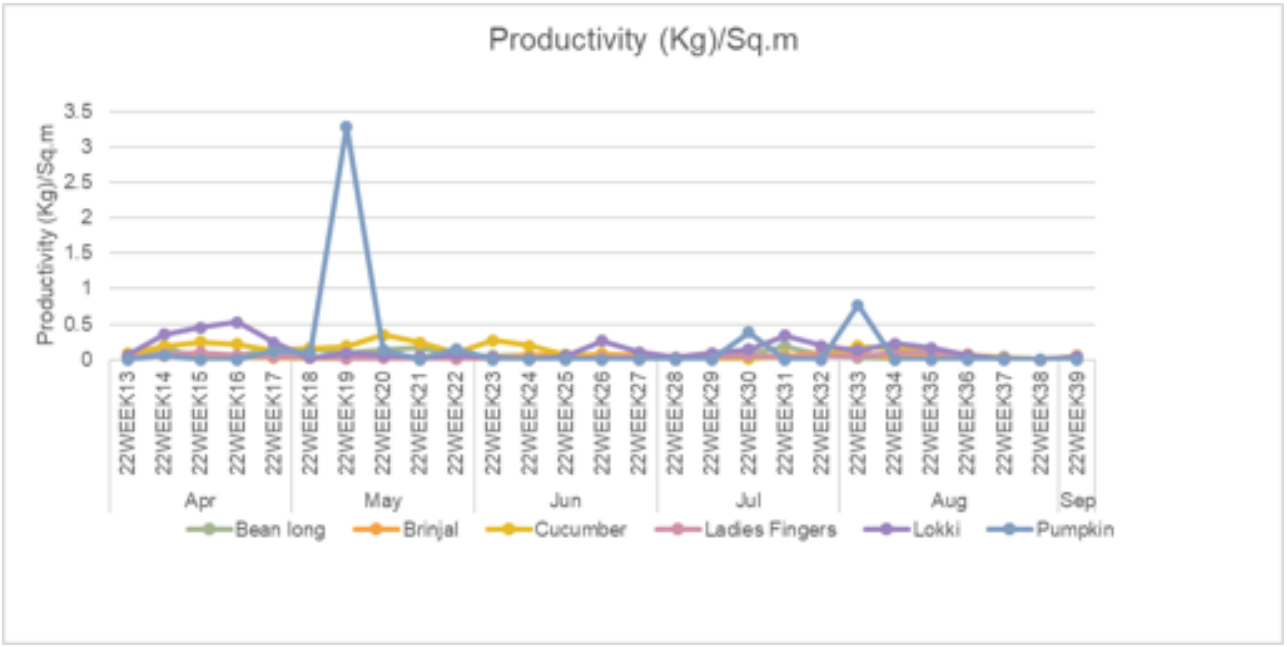


***Fig 8**: Weekly trend of productivity (Kg/Sq.m) of 6 vegetables*
Bean Long, Brinjal, Cucumber, Ladies finger, Pumpkin

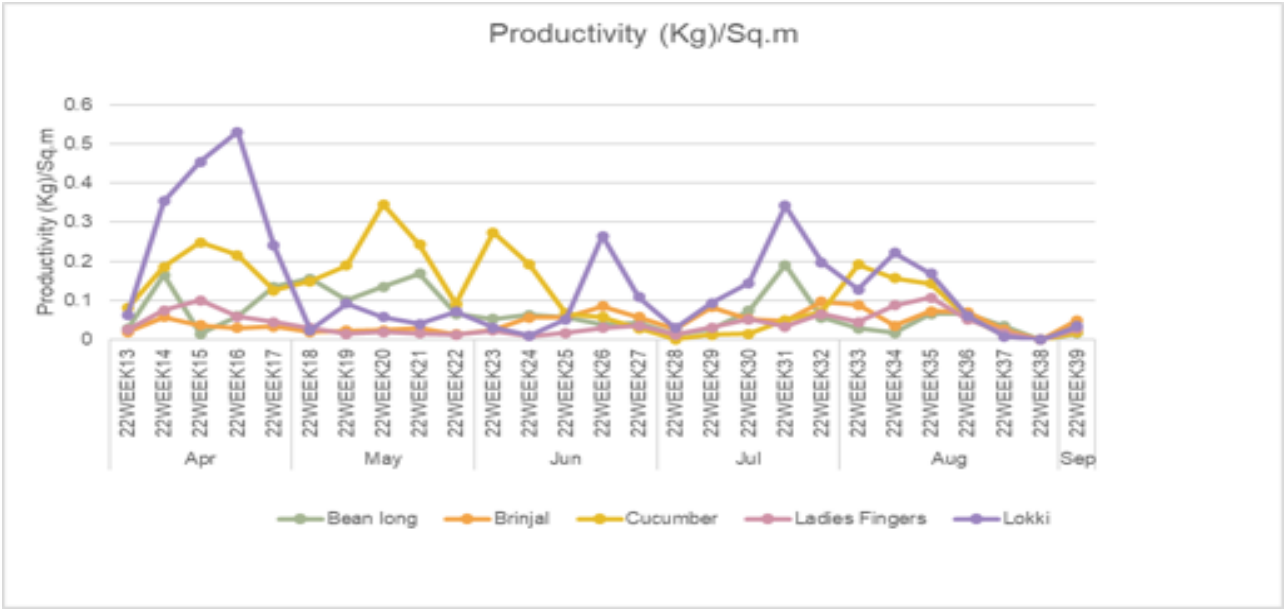


***Fig 9**: Weekly trend of productivity (Kg/Sq.m) of 5 vegetables*
Bean Long, Brinjal, Cucumber, Ladies finger

Observations:

1. Since we try to keep the areas planted with a certain crop consistent throughout the year, we can see that the productivity trend is similar to that of production (This is analysed further in the following pages).
2. The only difference here between plots and seasons could be losses due to pests and insects that could have led to having different numbers of plants in the plots or beds resulting in different production numbers. Therefore we cannot attribute the variations in productivity only to seasonal changes. We are looking into involving a team member to document this aspect in more detail.
3. As observed earlier, April-May and July-August seem the best seasons for Long beans, Lauki and Cucumber but the productivity is very erratic. This could be due to the delicate nature of these crops which make them vulnerable to various changes in the weather.
4. Brinjal productivity is less erratic than other crops. However, it increases post summer.
5. Ladies finger productivity is less erratic than other crops. It is high pre-summer (April) and post-summer (July/August).

5. Comparison of production (kg) and productivity (kg/sq. m)

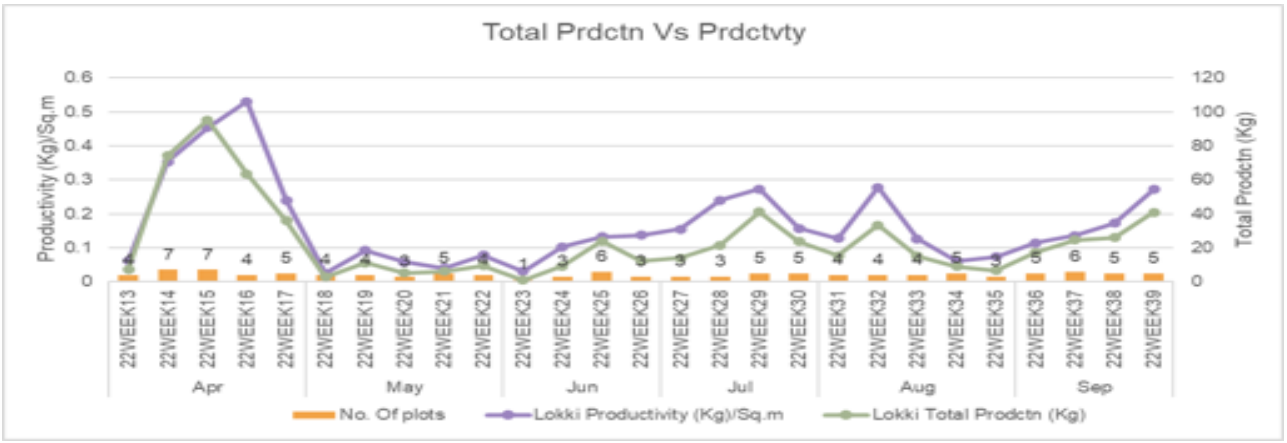


Fig 10(a):- *Comparison of total production (kg) and productivity (kg/sq. m.)*
For Lauki

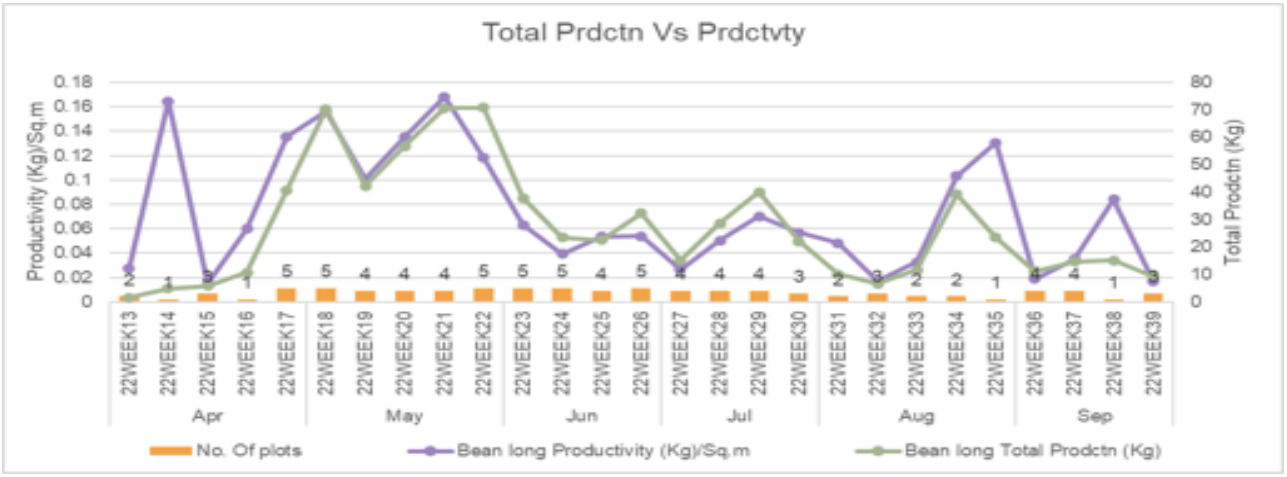


Fig 10(b):- *Comparison of total production (kg) and productivity (kg/sq. m.)*
For Bean long

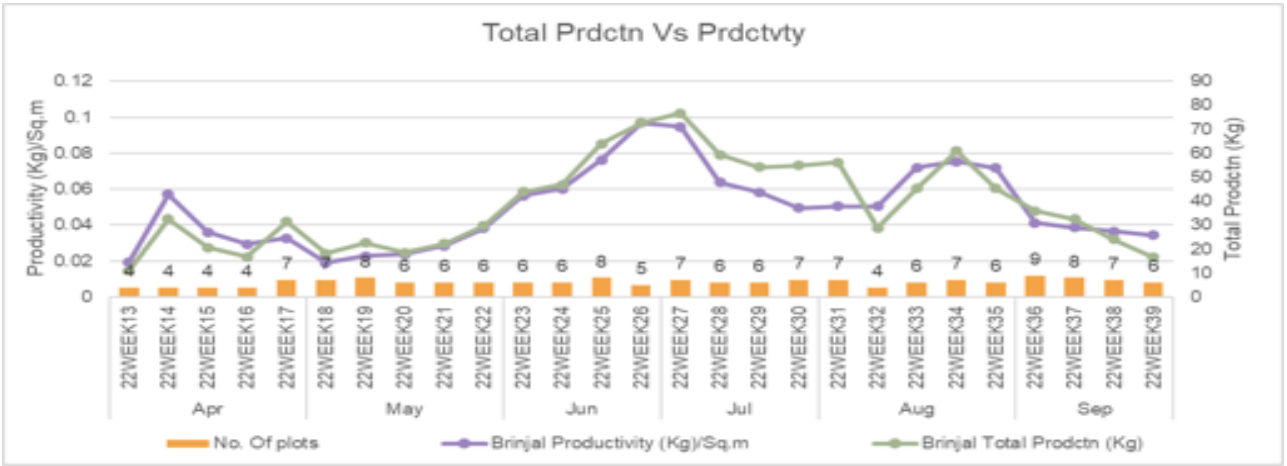


Fig 10(c):- *Comparison of total production (kg) and productivity (kg/sq. m.)*
For Brinjal

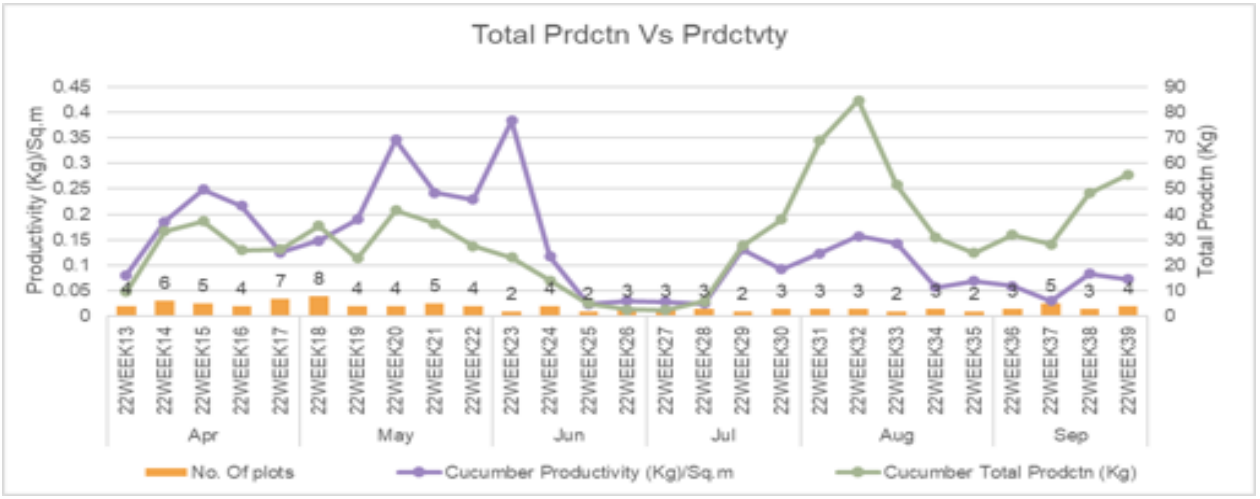


***Fig 10(d)**:- Comparison of total production (kg) and productivity (kg/sq. m.)*
<u>For Cucumber</u>

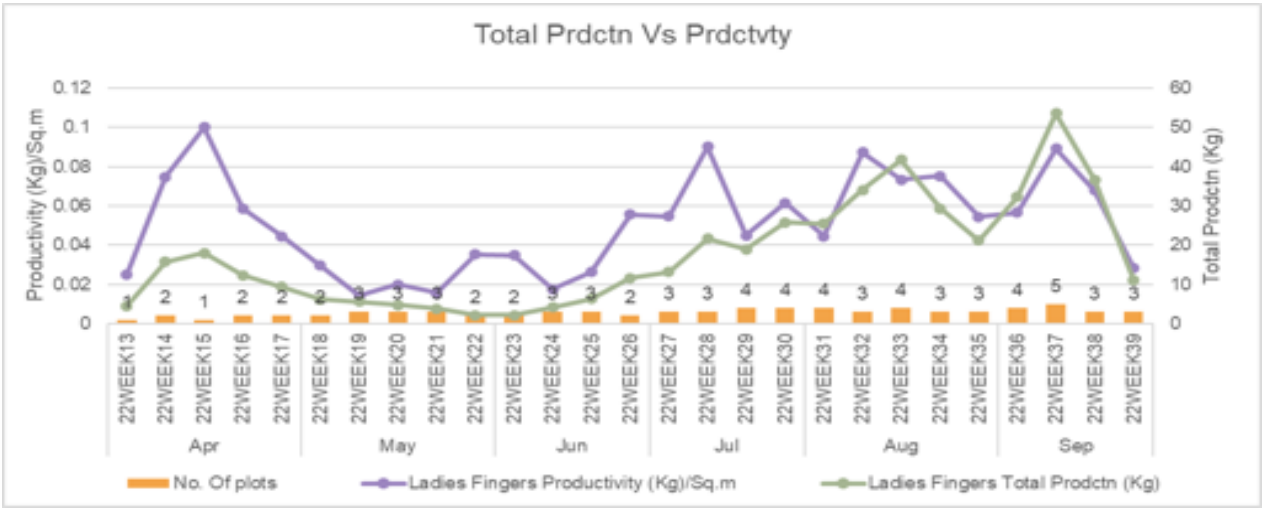


***Fig 10(e)**:- Comparison of total production (kg) and productivity (kg/sq. m.)*
<u>For Ladies fingers</u>

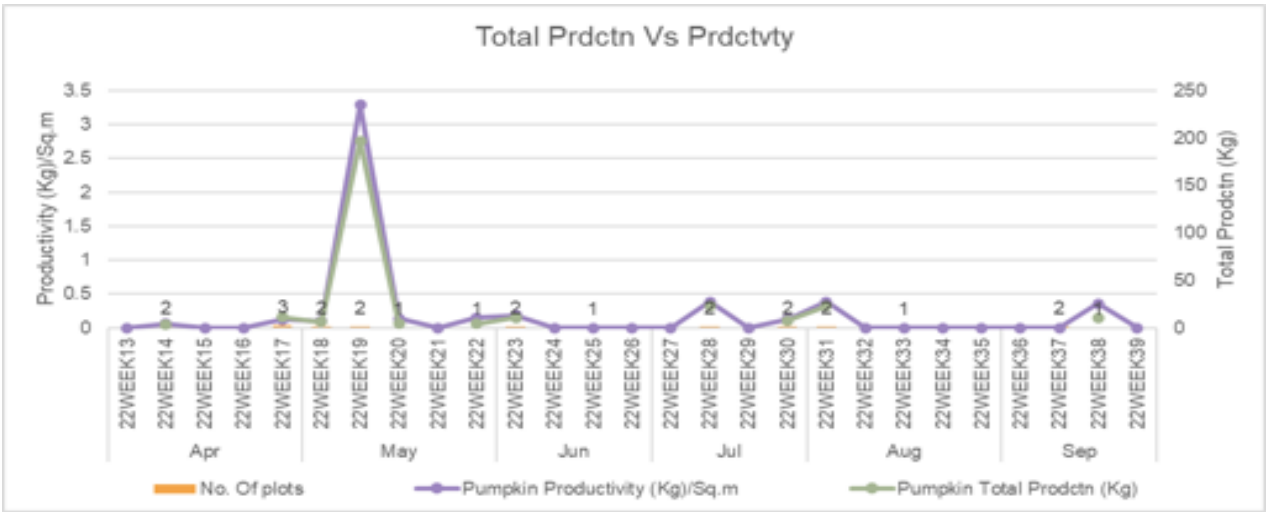


***Fig 10(f)**:- Comparison of total production (kg) and productivity (kg/sq. m.)*
<u>For Pumpkin</u>

Observations:

1. The variation in productivity and production trends where the number of plots/beds planted changes.
2. The trends for Lauki, Beans and Brinjal are more or less in sync, which means they were planted consistently and regularly.
3. The trends for Cucumber and Ladies fingers have large variations, possibly due to differences in areas cultivated, lack of consistency in planting, loss due to pests etc.

   Cucumber and Ladies fingers have been the most sensitive crops for this year and we have had difficulty in maintaining good and regular production from them. Also, we need better planning for these crops. As can be observed, they were not planted or protected from pests regularly.
4. The trends for pumpkin are in sync, also because the harvests are one-off and not so regular as is the case for other crops.

6. Plot Performance for Brinjal

Performance of plots, for Brinjal , across various beds, whose planting dates are reported in the given time period.

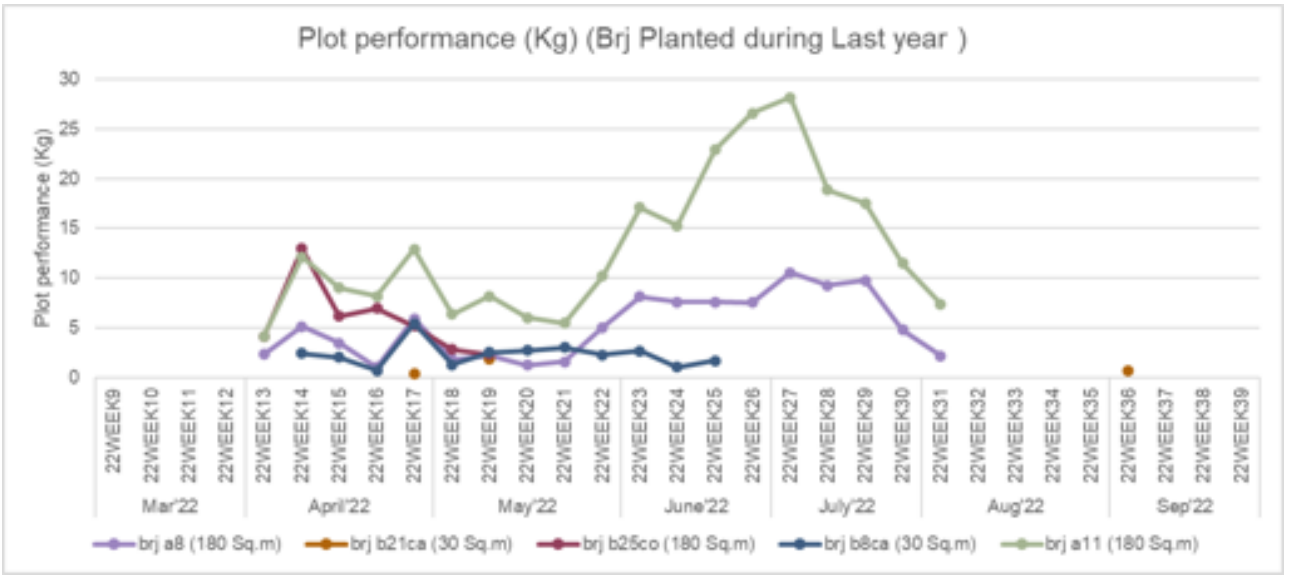


***Fig 11(a)**: Weekly trend in production (Kg) of Brinjal planted last year*

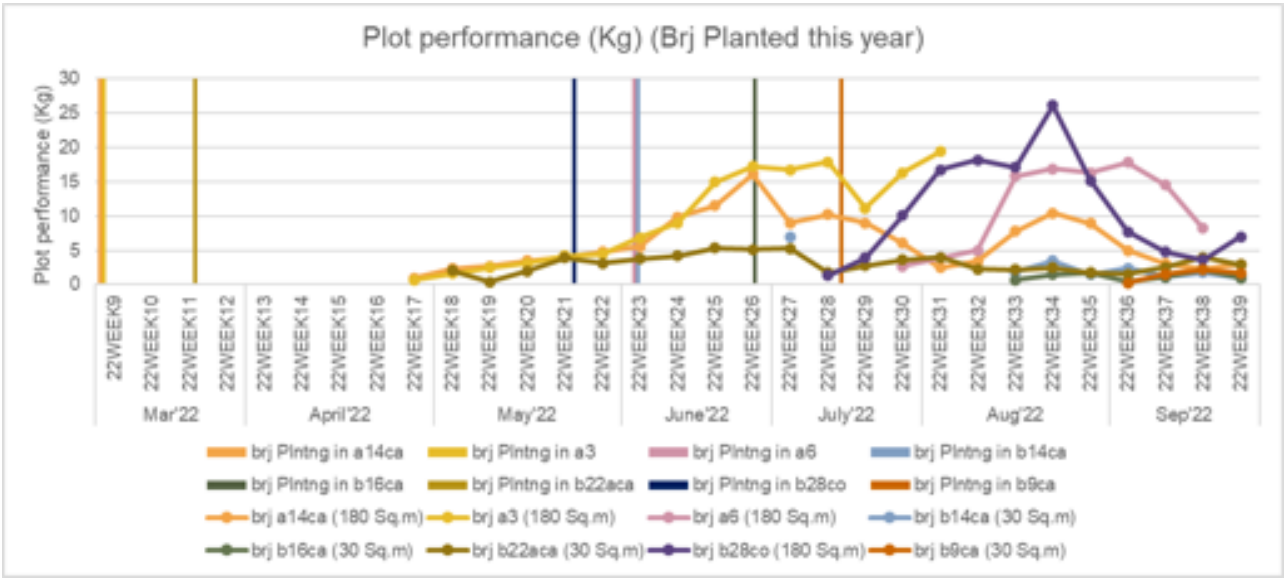


***Fig 11(b)**: Weekly trend in production (Kg) of Brinjal planted this year. The vertical lines indicate weeks of planting in respective plots.*

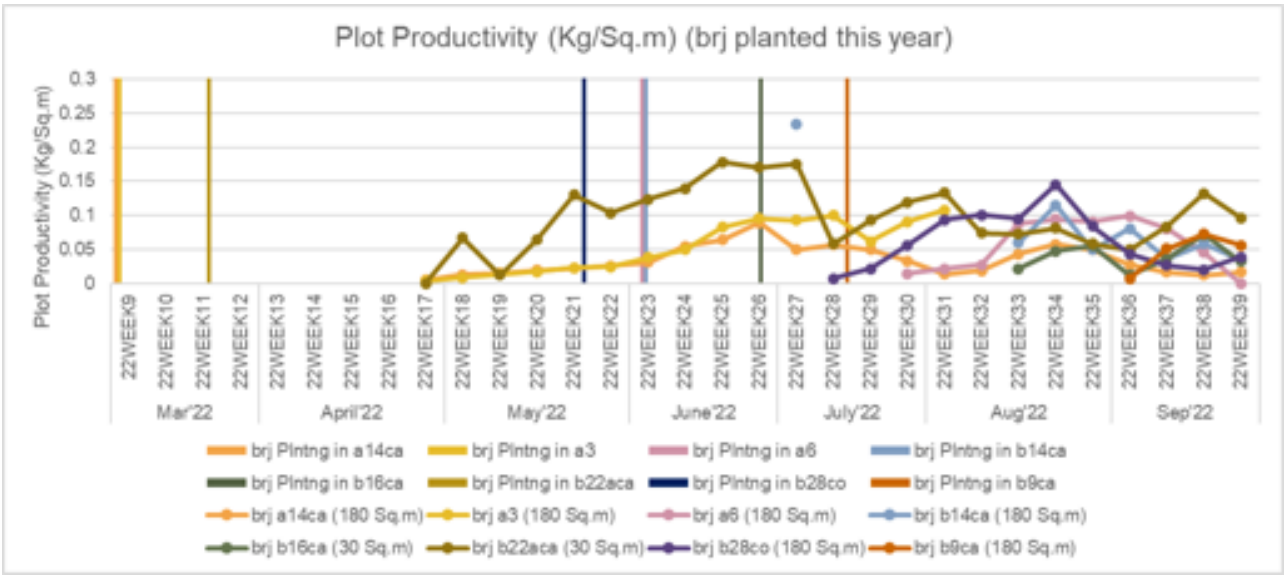


***Fig 11(c)**: Weekly trend in productivity (Kg/Sq.m) of Brinjal planted this year. The vertical lines indicate weeks of planting in respective plots.*

Overall Summary for Brinjal across various plots

Plot number	Planting Week Number	First harvest	Peak	Last harvest	Time from planting to first harvest	Time from planting to peak	Time from planting to last harvest	Area (Sq.m)	Crop cycle productivity (Kg/Sq.m)
a11	21WEEK50	22WEEK13	22WEEK27	22WEEK31	15 weeks	29 weeks	33 weeks	180	1.38
a14ca	22WEEK9	22WEEK17	22WEEK26	Ongoing	8 weeks	17 weeks	ongoing	180	0.79
a3	22WEEK9	22WEEK17	22WEEK31	22WEEK31	8 weeks	22 weeks	22 weeks	180	0.81
a6	22WEEK23	22WEEK30	22WEEK36	22WEEK38	7 weeks	13 weeks	15 weeks	180	0.56
a8	21WEEK49	22WEEK13	22WEEK27	22WEEK31	16 weeks	30 weeks	34 weeks	180	0.54
b14ca	22WEEK23	22WEEK27	22WEEK27	Ongoing	4 weeks	4 weeks	ongoing	30	0.67
b16ca	22WEEK26	22WEEK33	22WEEK38	Ongoing	7 weeks	12 weeks	ongoing	30	0.28
b21ca	21WEEK51	22WEEK17	22WEEK19	22WEEK36	18 weeks	20 weeks	37 weeks	30	0.1
b22aca	22WEEK11	22WEEK18	22WEEK25	Ongoing	7 weeks	14 weeks	ongoing	30	2.22
b25co	No data	22WEEK13	22WEEK14	22WEEK19	no data	no data	no data	180	0.22
b28co	22WEEK21	22WEEK28	22WEEK34	Ongoing	7 weeks	13 weeks	on going	180	0.73
b8ca	No data	22WEEK14	22WEEK17	22WEEK25	no data	no data	no data	30	0.92
b9ca	22WEEK28	22WEEK36	22WEEK38	Ongoing	8 weeks	10 weeks	ongoing	30	0.19

Observations:

1. At the time of planting, the plants are already 4 weeks old. So this should be added to the time period mentioned above in final calculations.
2. All crop cycles in each plot follow the expected bell shape, some with sharper peaks, and some with flat peaks.
3. On an average all plots started reporting production after 7-8 weeks (around 2 months) of planting.
4. Full crop cycle from planting to the last harvest varies from 15 to 30 weeks (4 to 7 months). This depends on the season. Crops planted during summer tend to ‘exhaust’ faster. They are never going to grow like robots are they!
5. The time between planting and the peak of production also varies between 13 to 30 weeks (3 -7 months). Crops planted during summer tend to peak faster.
6. Productivity (production per area) varies significantly across different areas.
7. Productivity of beds (b22aca) is significantly higher (more than double) than the average productivity of the plots planted around the same time(a3 and a14ca). This is perhaps due to the different management techniques employed in these 2 areas. *Beds* are rich with compost and mulch and are irrigated regularly with drip irrigation. *Plots* are cultivated with a tractor, receive compost every now and then but in modest quantities and have an infrequent irrigation cycle.

7. Comparison of productivity of three varieties of Brinjal

brj, brjb, brjc

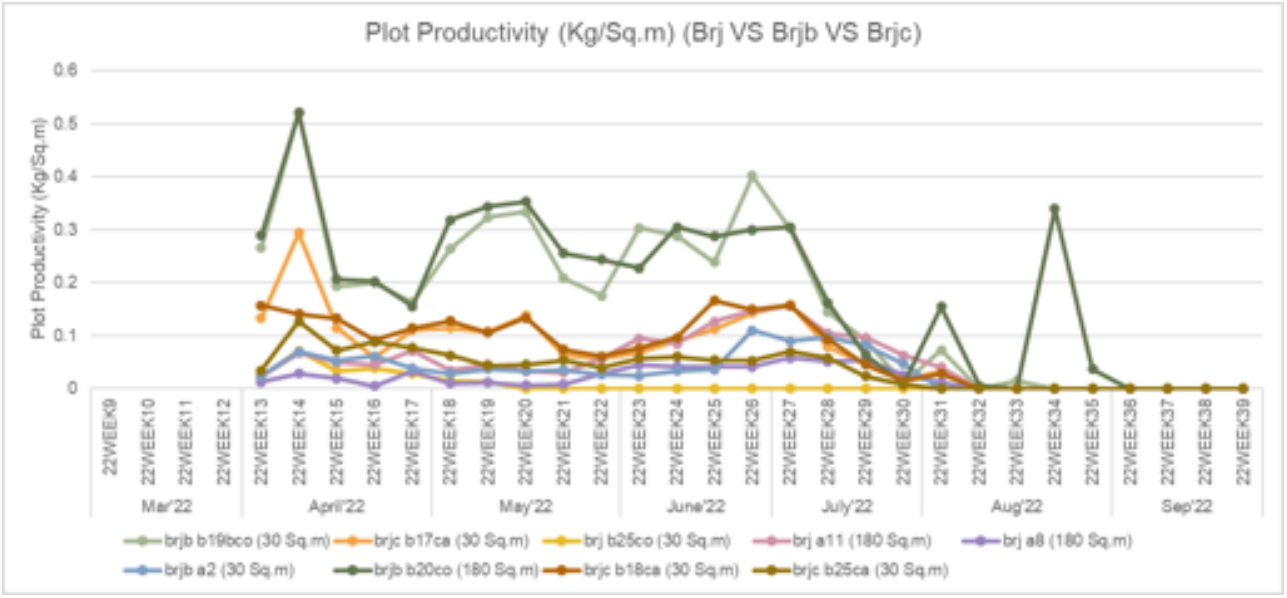


Fig 12: *Weekly trend in productivity (Kg/Sq.m) for Brinjal 3 varieties crops in 3 plots planted in week 51 of 2021*

AuroOrchard Brinjal (Annamalai): brj

Big Brinjal (Bharta): brjb

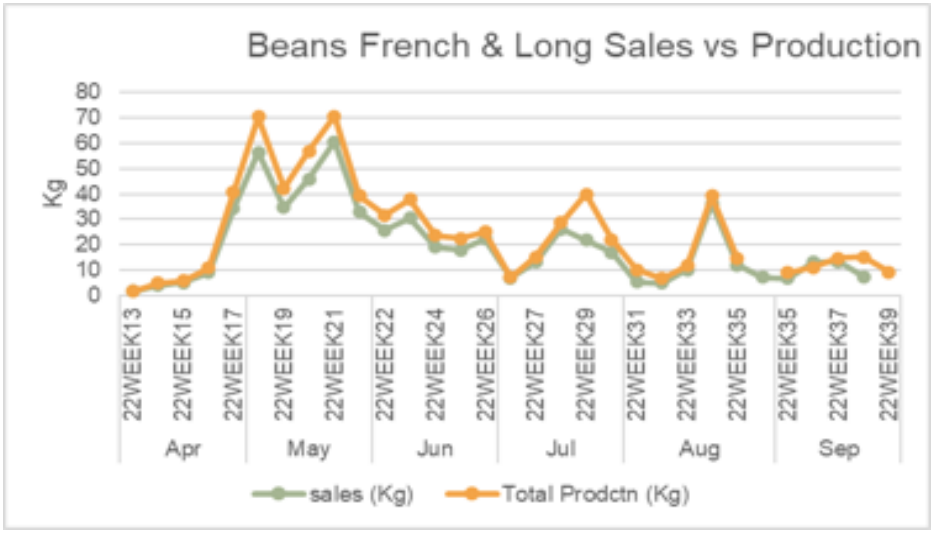
Striped Brinjal: brjc

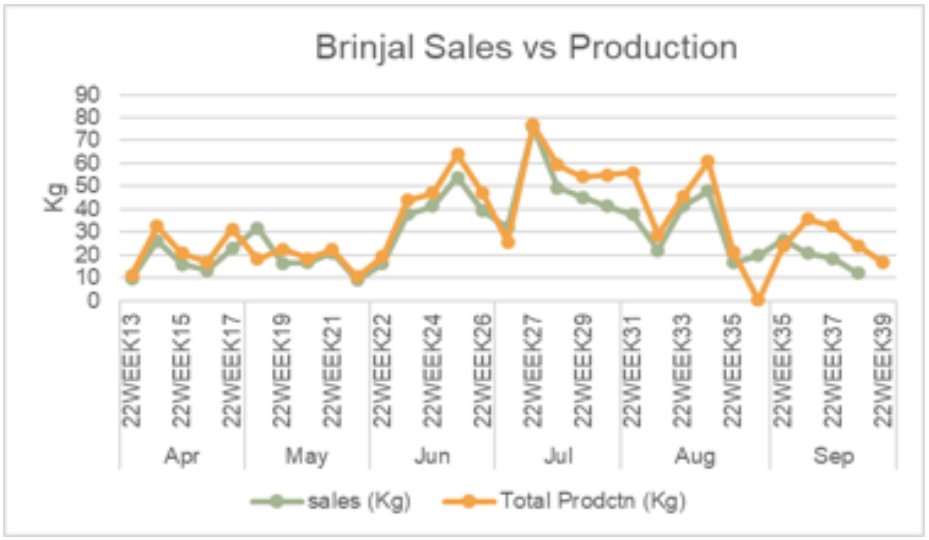
Variety	Location	Time of planting	first harvest	peak	last harvest	From Planting to first harvest	From planting to peak	From planting to last harvest	Area	Productivity (Kg/sq.m) over full cycle
brj	b21ca	21WEEK51	22WEEK17	22WEEK19	22WEEK36	18 weeks	20 weeks	37 weeks	30	0.1
brjb	b19bco	21WEEK49	22WEEK13	22WEEK14	22WEEK33	16 weeks	17 weeks	36 weeks	30	4.52
brjb	b20co	21WEEK49	22WEEK13	22WEEK14	22WEEK35	16 weeks	38 weeks	38 weeks	30	5.09
brjc	b17ca	21WEEK48	22WEEK13	22WEEK14	22WEEK31	17 weeks	35 weeks	35 weeks	30	1.94
brjc	b18ca	21 wEEK 48	22 wEEK 13	22 wEEK 25	22 wEEK 31	17 weeks	35 weeks	35 weeks	30	1.97
brj	a8	21WEEK49	22WEEK13	22WEEK27	22WEEK31	16 weeks	30 weeks	34 weeks	180	0.54
brjb	a2	21WEEK51	22WEEK13	22WEEK26	22WEEK30	14 weeks	27 weeks	31 weeks	180	0.93
brjc	b25ca	21WEEK51	22WEEK13	22WEEK14	22WEEK30	14 weeks	15 weeks	31 weeks	180	1.03

Observations:

1. These are three different brinjal varieties planted around the same time in December 2021 (30 days after starting in the nursery). This was verified from the planting sheet (physical sheet) of last year.
2. *Brinjal (brj)* is the AuroOrchard variety Annamalai that has been cultivated on the farm since over 40 years
   Brinjal B (brj b) is the big brinjal variety also popular as Aubergine used for mashed brinjal dishes.
   Brinjal C (brj c) is a medium brinjal, a local variety, green in colour with green stripes.
3. The time between planting and first harvest is comparable across all three varieties.
4. The time between planting and last harvest is longer for crops planted on beds than the ones planted in plots.
5. Within the crops planted on beds, the time between planting and last harvest is comparable across all three varieties.
6. With the crops planted in plots brj variety seems to last longer by 3 weeks and brjb and brjc seem to have similar life cycle.
7. According to the above analysis, ***brjb*** variety has the highest productivity on beds, while the ***brjc*** variety has the highest productivity on plots. Apart from their good production both these crops produced for far longer than other brinjal crops planted at the same time.
8. Both brjb and brjc varieties seem to be more productive than the brj variety which is popular in Auroville and many farms are growing now.
9. While in this table brj productivity on bed (b21ca) shows as 0.1 kg/sq. m. over the life cycle of the crop, we have seen higher productivity numbers for brinjal on beds. e.g. 2.2 kg/sq. m. from b8ca (See table after Fig. 11(c)).
10. We found brjb to be popular among our customers and brjc not so much. From the figures above, it would seem that brjb could be developed a bit more on the farm as it is bigger fruit, higher production and productivity and also liked by the community. We would also continue to grow the heritage variety of Brinjal at AuroOrchard (brj) which has been developed here for over 40 years. However, growing two different varieties of brinjal creates the chances of cross pollination and the challenge with keeping seeds of the true variety. If we do this, we'll have to pay close attention that we are able to continue growing two <u>different</u> varieties and keep their desired characteristics distinct.
11. While this definitely shows the potential for brjb and gives an initial idea, the production and productivity figures should be compared for brj and brjb for more plantings to arrive at a conclusion.

8. Sales vs production for 6 crops





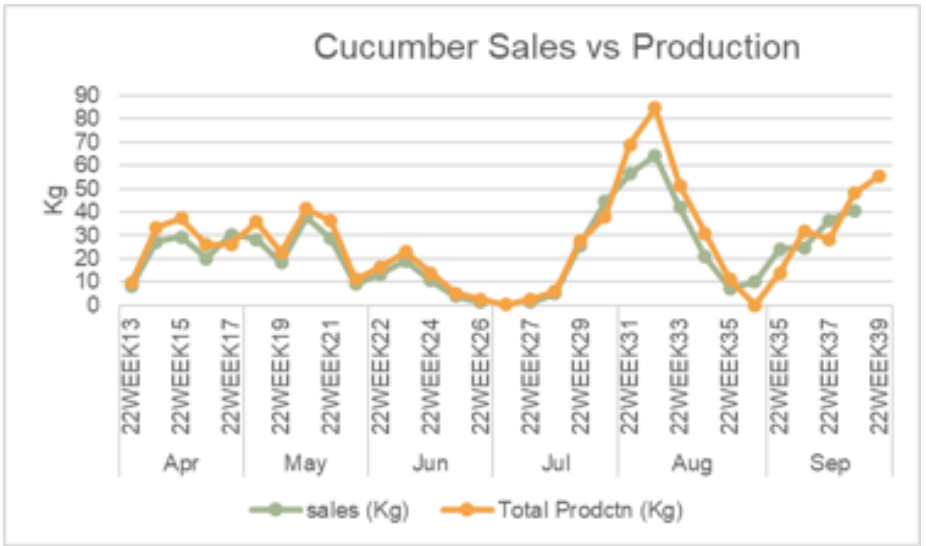


***Fig. 13**: Comparison of production value and sales value for Beans, Brinjal and Cucumber*

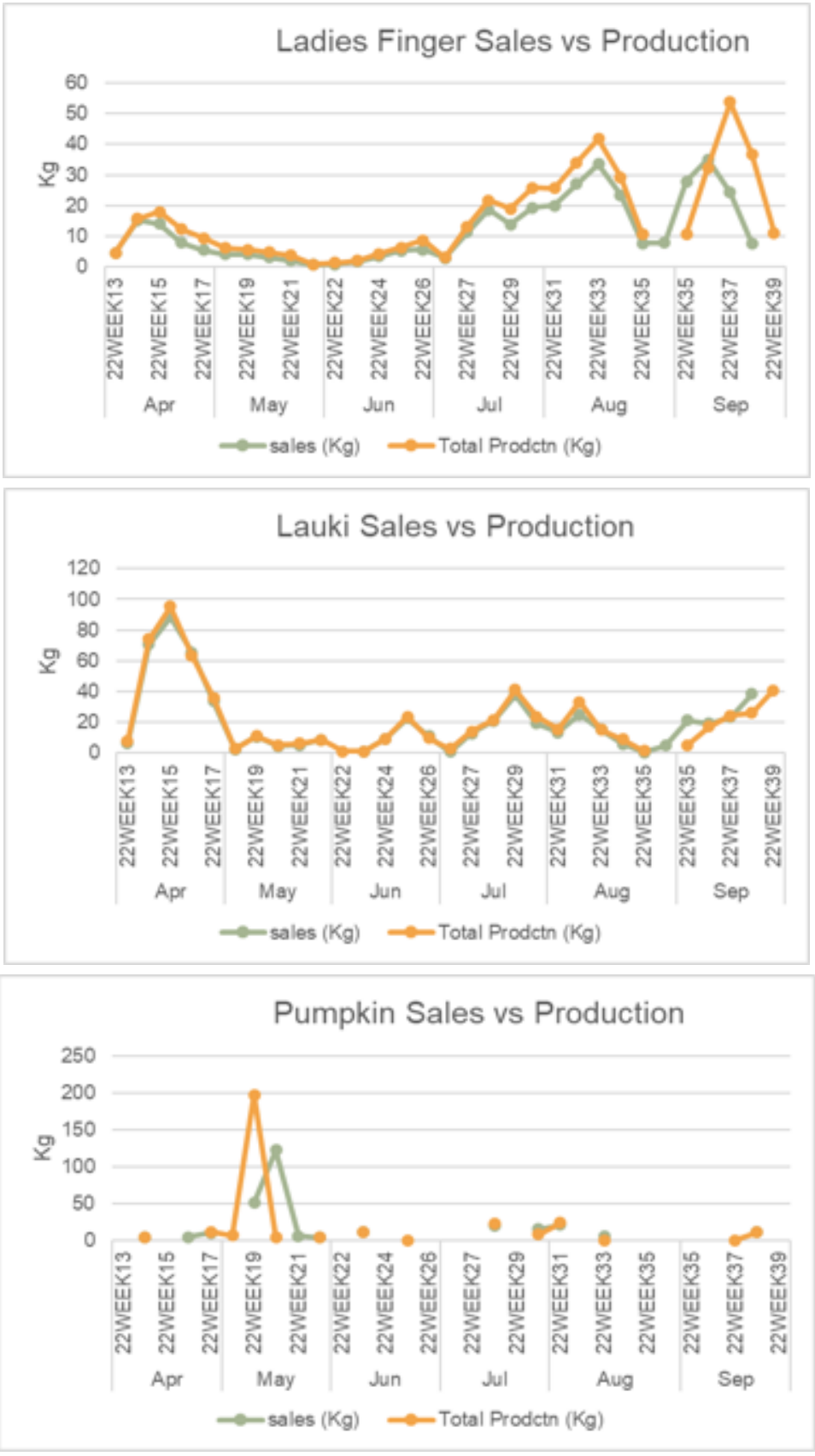


***Fig. 14**: Comparison of production value and sales value for Ladies finger, Lauki and Pumpkin*

Percentage loss between production and sales

Months	Week	Beans Long	Brinjal	Cucumber	Ladies Finger	Lauki
Apr	22WEEK13	1%	13%	18%	0%	14%
	22WEEK14	19%	20%	18%	3%	5%
	22WEEK15	10%	23%	21%	22%	7%
	22WEEK16	16%	21%	22%	37%	-
	22WEEK17	16%	27%	-	41%	7%
May	22WEEK18	20%	-	20%	33%	16%
	22WEEK19	18%	27%	20%	28%	2%
	22WEEK20	19%	10%	9%	36%	11%
	22WEEK21	14%	6%	21%	48%	16%
	22WEEK22	17%	16%	18%	28%	7%
Jun	22WEEK23	19%	14%	17%	19%	-
	22WEEK24	19%	12%	24%	21%	1%
	22WEEK25	20%	16%	22%	16%	4%
	22WEEK26	8%	2%	52%	28%	6%
Jul	22WEEK27	12%	1%	45%	14%	10%
	22WEEK28	9%	17%	15%	14%	3%
	22WEEK29	45%	16%	7%	26%	8%
	22WEEK30	23%	25%	-	25%	18%
Aug	22WEEK31	46%	33%	18%	21%	12%
	22WEEK32	27%	24%	24%	21%	24%
	22WEEK33	14%	9%	18%	19%	0%
	22WEEK34	7%	21%	32%	20%	36%
	22WEEK35	17%	20%	30%	27%	16%
Sep	22WEEK36	38%	26%	25%	14%	-
	22WEEK37	10%	36%	12%	34%	22%
	22WEEK38	12%	24%	24%	34%	10%
	22WEEK39	18%	27%	27%	31%	5%
AVERAGE		**18%**	**19%**	**17%**	**24%**	**11%**

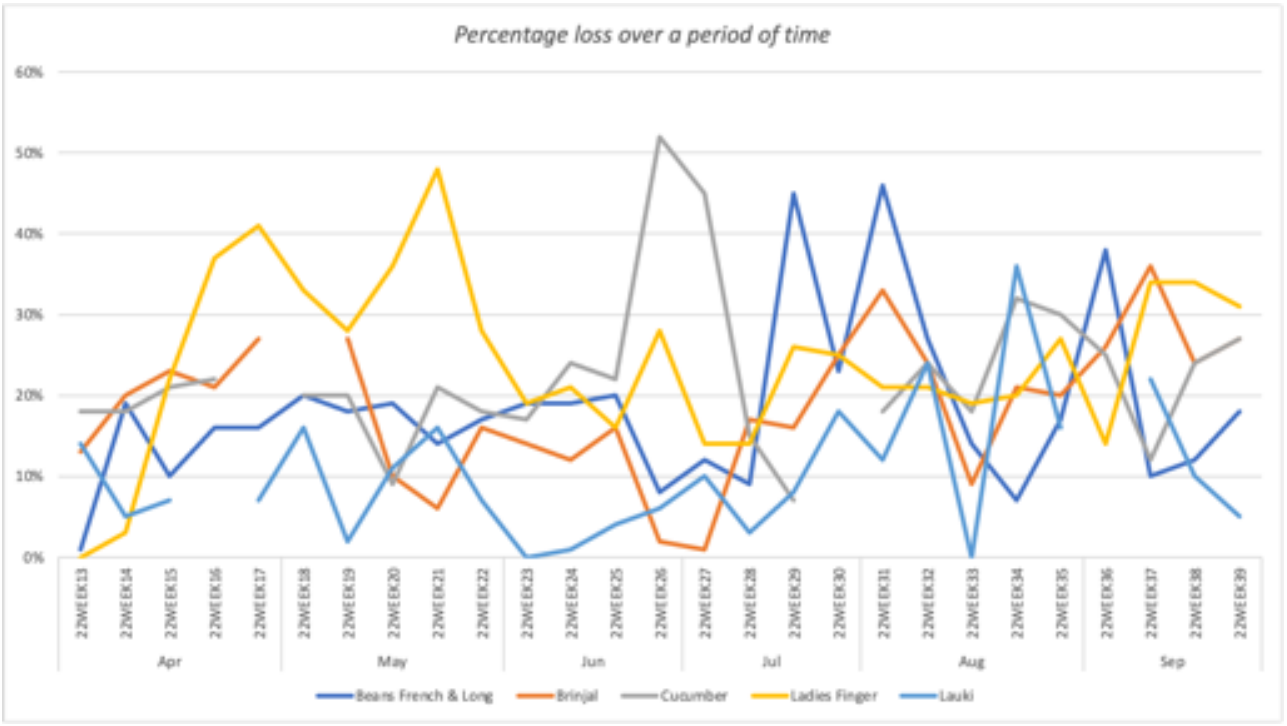


***Fig 15**: Percentage loss over a period of time*
for Beans, Brinjal, Cucumber, Ladies fingers, Lauki, Pumpkin, Big Brinjals

Observations:

1. The trends for sales and production are similar.
2. The difference shown in sales and production mean that something was harvested but not distributed. The only reason for this could be that a portion of the harvested produce was damaged or overripe and was not marketable. Or was eaten by people on the farm? This portion of the harvest is either composted or distributed within our team.
3. Some weeks and some dates show more sales than production. This is bad data. We are verifying this. Oh dear! you are right it needs looking into.
4. Marked differences can be observed in Beans, Ladies fingers and Brinjal. We often lose a portion of the crop to pests and overripening.
5. Highest losses are reported for Pumpkin and big brinjal varieties (brjb & brjc), 38% and 37% respectively.
6. The six month average loss for Ladies Fingers is 24% i.e. a quarter of the crop was lost during 6 months to overripening, presence of blemishes, holes etc. Similarly, the six month average loss for Beans and Brinjal is 18% and 19% respectively i.e. one-fifth of the crop was lost during 6 months to overripening, presence of blemishes, holes etc.
7. Sometimes the crop is left standing just because there is no rush to take it out. And if it still produces something, it is recorded and that time adds to its productive time, when in fact it is not the productive time for the crop and if the crop was removed earlier, productivity/day would be higher and losses would be less. This needs to be considered more carefully and we may choose to remove a crop after a certain low level of production is reached (e.g. when a plot yields only 10 kg/plot, the crop could be removed).
8. The lowest losses are reported for Lauki and Cucumber 11% and 14% respectively.

9. A comparison of losses between brinjal and big brinjal varieties shows that while the production of brinjal varieties (brjb and brjc) may be higher than brinjal, they also suffer double the loss. This is important in considering which of these crops is finally more valuable and productive.
10. Highest losses are reported around July and September.

Conclusion and next steps

- We are happy to have progressed on this work and while we are just starting, we are excited about the possibilities that this data can offer.
- The analysis done so far is only preliminary and we are far from any conclusions. But we can already observe some trends and having the data will make it easier to observe these patterns even more closely.
- We will begin counting the number of plants in each field that survive after planting. This will give us a clearer picture of productivity per plant. Very good
- Similarly, we need to include 'time' as a factor in productivity. For example, current productivity numbers are for kg/sq. m.
  However, the overall production depends on the time duration of the crop harvest. Therefore, a more accurate unit may be kg/sq.m/day or kg/sq. m./week. This data will need to be related to season, temperature and rainfall. So we may have productivity figures for different seasons and weather conditions. I would add here relating to temperature and rainfall.
- We will begin collecting water data from January/February 2022 (after the monsoon) and explore how to correlate it with the production data.
- After creating a system for water data analysis and being comfortable in working with that data, we need more thought into how to segregate our accounts data to understand investments in a crop. This will have to take into account the labour used for a crop by recording weeding frequency, compost quantity, mulching frequency, harvesting frequency etc.
- It will be interesting to compare the productivity data with local agriculture department values, experiences from other farmers (ensuring that data is for organic cultivation) etc. Yes but make sure you are comparing the same things especially with regard to organic/non organic.

For any questions or suggestions, please write to us.

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Updates from November 2022

Management techniques for different growing areas:

	Plot	**Raised Bed**
Average area	180 sq. m.	30 sq. m
Cultivation	Shallow disking	No till
Preparation	Green manure crops such as sunn hemp are grown after a crop is finished. This is allowed to grow for about 60 days until it begins flowering. At this point, it is cut back into the soil using a disc harrow on a tractor. The disking is done to a depth of 10 -15 cm to minimise the disturbance to the soil while incorporating the green manure in the surface layer.	Green manure crops may or may not be used. Here compost is used more intensively to enhance the health of the soil. After a crop is finished, the residues are removed, a 5 cm layer of compost is added followed by a 15-20 cm layer of mulch consisting of chipped fresh wood or dry leaves. The bed is left to rest for 1-2 weeks before planting again.
Composting	Limited due to lack of availability. Compost is applied to each plant rather than the entire growing area. Compost is turned into the soil.	Used on the entire bed as a thick layer on top of the soil rather than turning it into the soil.
Mulching	Use of cover crops like horsegram, cow pea in between the standing crop.	Use of chipped fresh wood, leaves, straw, grasses on top of the compost layer.
Weeding	Every 20-30 days depending on crop and season (more frequent for young plants). Traditional practice of digging the soil lightly to get the roots of the weeds out.	Every 20-30 days depending on the crop and season (more frequent for young plants). Weeds are pulled out by hand, no tools are used. No digging.
Soil compression	Some compression as workers walk on the plot regularly for weeding and harvesting.	No compression as the bed is accessed by the path adjacent to it.
Irrigation	Flood irrigation or sprinklers	Drip irrigation