AMAIZZ fresh air dryer pilot (Chili) in Andhra Pradesh - Concluding report

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May 12, 2019

Executive Summary

A. Objective:

The pilot was aimed to monitor and asses the AMAIZZ fresh air dryer performance in comparison with the traditional sun-drying method, in order to determine whether it is financially beneficial to the farmer.

B. Result summary:

1. Test 1: Drying time: 26 days. At the end of the period:

Table 1. First cycle summary

	Treatment	Treatment simulation	Control (Different farmer)	Control (Farmer reported)	Comments
Weight in (kg)	600		Unknown	6,900*	*Farmer estimated weight
Weight out (kg)	232		Unknown	2900**	**Based on selling information
Weight out %	38.67%			42.03%	
Drying time (days)	26	20	18	20	
E-Nam market lab quality Parameters (weight %)					
Sample size (g)	810		220***		***High quality sample from neighboring farmer
good	79.18		63.49		
full length	83.46		80.35		
half length	6.01		4.17		
Without stalk	7.04		21.75		better without stalk
Broken	4.74		5.05		
Discolor	0		0		
Foreign Matter	2.08		5.28		
Loose seed	0.96		0.26		Better loose seeds
E-Nam lab test: average (moisture %)					
High grade	12.28		10.4****		****E-Nam approximated 200 INR Less for high grade in the control sample
Low grade	13.52		0*****		*****No low grade in the control sample
Dreyer produce after 20 days		15.2******			******tested in field before sorting
Quality assessment of total dry produce (weight %)					
High grade	68.97			76	
Low grade	31.03			24.14	
Total per KG dry/wet produce (INR)					

Total sale value per KG of dry Chili	65.86	67.14
Total expenses per KG of dry Chili	15.34	4.55
Net profit per KG of dry Chili	50.52	62.59
Total sale value per KG of wet Chili	25.47	28.22
Total expenses per KG of wet Chili	5.93	1.91
Net profit per KG of wet Chili	19.53	26.31

Notes: 1) Treatment simulation: moisture level on same day the farmer sold his produce. 2) Expenses include: hired labor for sorting, transportation to drying site, hired labor for loading the dryer and sorting, buyer commission and electricity (approximated). Expenses do not include pilot costs: cost of machine, installation costs and operators time.

2. Test 2: Drying time: 17 days. At the end of the period:

Table 2. second cycle summary

	Treatment	Control	Comments
Weight in (kg)	1000	1000	
Weight out (kg)	416	551.6	
Weight out %	42%	55%	
Drying time (days)	17	8	
E-Nam market lab quality Parameters (weight %)			E-Nam lab test was not conducted
E-Nam lab test: average moisture %			E-Nam lab test was not conducted
Quality assessment (weight %)			
High grade (kg)	87.98	87.90	
Low grade (kg)	12.02	11.92	
Total INR per KG			
Total sale value per KG of dry Chili	73.39	72.83	
Total expenses per KG of dry Chili	13.15	7.25*	*Expenses include workers for grading only
Net profit per KG of dry Chili	60.24	65.58	
Total sale value per KG of wet Chili	30.53	40.17	
Total expenses per KG of wet Chili	5.47	4.00**	**Expenses include workers for grading only
Net profit per KG of wet Chili	25.06	36.17	

Notes: Expenses include hired labor for sorting, transportation to drying site, hired labor for loading the dryer and sorting, buyer commission and electricity (approximated). Expenses do not include pilot costs: cost of machine, installation costs and operators time.

C. Conclusion:

In contrast with what was expected, no real evidence of the fresh-air dryer expediting the drying process was found during the pilot. In both cycles, it seems that even though fresh-air drying took longer, moisture levels was higher in comparison with the control group. Other parameters of quality, however, proved to be slightly higher in the treatment group (first cycle), but the increase in revenue resulting from that gap was very far from justifying considering the machine as a replacement for the farmer's traditional practices.

AMAIZZ fresh air dryer pilot (Chili) in Andhra Pradesh - Concluding report

A. Introduction

Traditionally small-holder farmers in Andhra Pradesh (AP) dry their Chili produce before selling it in local and sometimes E-Nam markets. The method most commonly used is sun-drying in the farmer's field (on a tarp or directly on the ground). During this process the produce is exposed to different weather conditions and contaminations (fungal and other), which causes loss of produce and damage resulting in poor quality.

Industrial solutions to drying chili exist in the market for many, yet they are mainly designed to accommodate large quantities (and big farmers) and are often not suitable to the small-holder farmer's needs. There are not many solutions to post harvest losses designed for small-holder farmers who are not only limited in resources, but are also more exposed to risks arising from traditional drying methods. AMAIZZ technology was chosen for its potential to offer low cost, small dryers for small-holders.

The pilot was aimed to monitor and asses the AMAIZZ fresh air dryer performance in comparison with the traditional sun-drying method, in order to determine whether it is financially beneficial to the farmer. If the pilot would have proved successful, information regarding drying time and return prospects would have been incorporated in the design process for a suitable business model for dissemination of the technology based on real tests.

Eventually, however, the process of conducting this pilot was fraught with difficulties, to the extent that it can be concluded as unsuccessful. In this report, we strive to give an objective account of this process, and of some of the reasons leading to this conclusion.

B. Dryer technology and the selection of AMAIZZ

1. Potential advantages of the dryer: Reduces drying time, reduces produce loss and Improves dried produce quality.
2. Selection process of AMAIZZ technology:
    a. As a result of the TAU fellows prior visits to India, as well as dissections with TATA Trusts personal, arose an insight regarding substantial post-harvest losses suffered by many small-holder farmers, sometimes due to lack of access to an affordable post-harvest treatment technology.
    b. AMAIZZ was chosen in accordance with the recommendations received from the Innovation Authority and Pears Program, and a review of AMAIZZ's pilots conducted in Africa with Amaizz.
    c. Initial meetings with TAU team.
    d. Meeting with TATA-Trusts delegation to the Agritech expo in Israel, May 8-10 2018.

3. AMAIZZ engagement time line

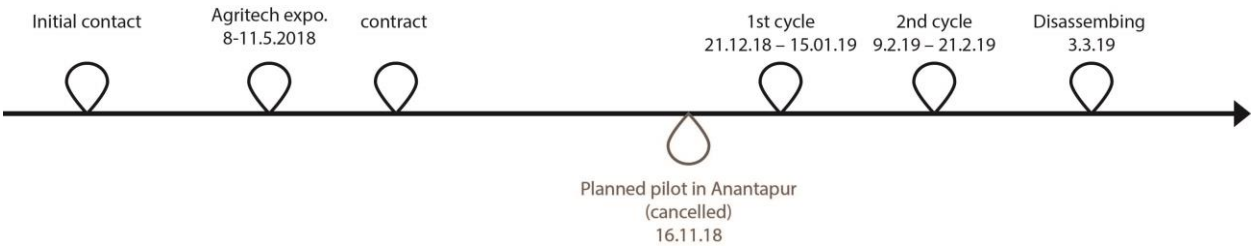


Figure 1: AMAIZZ pilot timeline

C. AMAIZZ fresh air dryer pilot (Chili) - details

1. Location
    a. Initially the dryer was to be piloted in two different districts, for two different crops: Anantapur (Groundnuts) scheduled to take place in November 2018, and Guntur (chili), scheduled to take pace in December 2018. Due to delays in shipping, by the time all necessary parts arrived on site the groundnut season was over and as a result the pilot in Anantapur district did not take place.
    b. For the pilot in Guntur, the location for the dryer was selected by VCF team, in coordination with AMAIZZ team and TAU fellows. The parameters taken into account while choosing the location were: AMAIZZ's requirements (continuous electricity supply, sufficient space outdoor, leveled ground, on-site operator and proximity to roads for transporting the produce), available produce and potential market (i.e. areas where chili is commonly grown and the dryer could be of substantial impact). The final location selected was in Guntur district, Durgi mandal, one of three major mandalas in the chili growing area.
    c. Installation took place between: 18-19.12.2018 (see appendix D: AMAIZZ Fresh air dryer installation – inquiry).
2. Monitoring protocol
    a. The monitoring protocol was designed to evaluate the performance of the dryer and capture data regarding: drying time, quality of produce and losses.
    b. While assembling the dryer on site, Mr. Ido Batchko, COO & Co-Founder of AMAIZZ, informed both TAU and VCF team regarding the fact that part of the design process was to take place in the field, and that there are a few on-site trials necessary to determine the final configuration of the dryer. These necessary trials were attributed to the fact that this was the first pilot to be conducted with the AMAIZZ fresh air dryer for chili (excluding the pilot with Syngenta foundation in Bihar, which took place in August 2018, for which we were not able to obtain data). This fact was not brought forth in advance by the AMAIZZ team, and resulted in some revisions in the pilot's design.
    c. Accordingly, the preliminary steps were decided upon by VCF agronomist Mr. Veerabhadra Reddy and AMAIZZ COO Mr. Ido Batchko (see appendix A: AMAIZZ Fresh air dryer Pilot (Chili) – Layout), and a new monitoring protocol was designed by TAU fellows to allow for evaluation of the performance of the dryer and its impact on the produce (see appendix B: AMAIZZ Fresh air dryer pilot (Chili) - monitoring protocol).

d. Two local operators were hired on a monthly salary basis by VCF to conduct and monitor the experiment. Both operators live in proximity to the dryer site, have academic background and connection to the local FPO.

3. Farmer selection process:
   a. Initially each trial was designed to include produce obtained from several farmers in order to exclude the differences arising from different growing methods.
   b. As the need for preliminary trials arose, it was necessary to revise the plan to allow for better understanding of the performance of the dryer, and have as much uniformity as possible to determine the optimal configuration inside the dryer. Therefore, one farmer was selected for each cycle. Farmers were selected by VCF agronomist following FPO recommendation.
4. As drying time took longer than expected, availability of produce and changes in weather conditions allowed for only two rounds to take place. The two rounds were conducted as follows:

Table 3. Details summary

	1st cycle	2nd cycle
Date	21.12.18 – 15.01.19	9.2.19 – 25.2.19
Total drying days	26	17
Variety	Teja Red Chili	Teja Red Chili
Amount	600 kg	1,000 kg
Control sample	220 g (sun dried in another farmer's field) + information from farmer regarding the produce not dried in the dryer	1,000 kg (sun dried in farmer's field)

D. Experiment overview

1. Objectives:
   a. To determine optimal loading layout for the fresh air dryer with different chili verities, including spacing and capacity.
   b. To determine optimal drying time for different chili verities.
   c. To assess the quality of all dried produce, both sun dried and machine dried, in different chili verities.
   d. To allow the farmer to experiment with new technology without risk.
2. Protecting the farmer: An agreement was drafted where the farmer would be compensated for any income loss caused by the use of the dryer, compared with the control sample.
3. Methodology:
   a. The preliminary steps were designed to include four trials, in which, each cycle will include increasing quantity of chili and different loading distribution to allow for the evaluation of different areas of the dryer and under different capacity. The trials were to include the following cycles:
      1) First cycle: 600 kg, loading 2 rows (out of 3), stacks A1, A2, A4, A7, B1, B2, B4, B7 (Full) 3 kg per tray (see figure 1 and 2 below).
      2) Second cycle: 1000 kg, loading 2 rows (out of 3), all stacks, 3 kg per tray.
      3) Third cycle: 1000 kg, 3 rows, produce distributed through all 21 tray stacks, 15-17 trays per stack of 25 trays filled with produce, 3 kg per tray.
      4) Fourth cycle: 1,500 kg, full capacity (all 525 trays filled with produce).

b. For each trial, there was supposed be a control group of matching quantity, dried by the farmer in his traditional method and monitored regularly (see appendix C: AMAIZZ Fresh air dryer pilot (Chili) - site visit 16-17.01.2019, farmer interview).

c. In order to track the drying process and outcome, and compare treatment with control groups, designated trays indicative to the performance of the dryer (considering air flow and potential risk areas) were selected, marked and monitored daily:
   1) Weight loss – weighed by digital scale on site twice a day.
   2) Moisture check – tested on site with designated moisture meter.
   3) Daily pictures of sample trays – via WhatsApp.

d. Upon completion, the produce was to be tested in E-Nam lab in Guntur for quality assessment and approximation of market price.

e. Next steps were to include different verities of chili and multiple farmers.

E. First cycle overview

1. Treatment group
   a. Duration of first cycle: 21.12.18 – 15.01.19 (26 days total)
   b. Amount: 600 kg (all from 1 farmer)
   c. Variety: Teja Red Chili
2. Control group
   a. Delays in the arrival of the last parts and the last payments to AMAIZZ which caused difficulties in coordinating the installation, were crucial in light of the upcoming season end and the beginning of harvest. These in turn made the pressure to begin the pilot all the more critical. Unfortunately, due to all these delays, a proper control group was not available and the monitoring protocol was not fully applied.
   b. In order to overcome this obstacle, and have a good approximation of the control group's situation, the following steps were taken:
      1) The farmer who provided the produce for the first cycle was interviewed regarding the produce dried in his field (see appendix C: AMAIZZ Fresh air dryer pilot (Chili) - site visit 16-17.01.2019).
      2) A sample of 200 g of dried chili of the same verity, dried using the same technique, was taken from a neighboring farmer to be tested at the E-Nam lab in Guntur at the same time as the samples from the treatment group.
3. Protecting the farmer: due to past experience with the drip experiments, where a formal, legally binding agreement proved to be an obstacle to the recruitment of farmers, and in light of the time pressure it was decided by VCF team not to sign the agreement with the farmer, but rather to have a verbal agreement between the farmer and VCF agronomist.

4. First cycle dryer configuration consisted from 2 rows, as shown in figure 1 below:

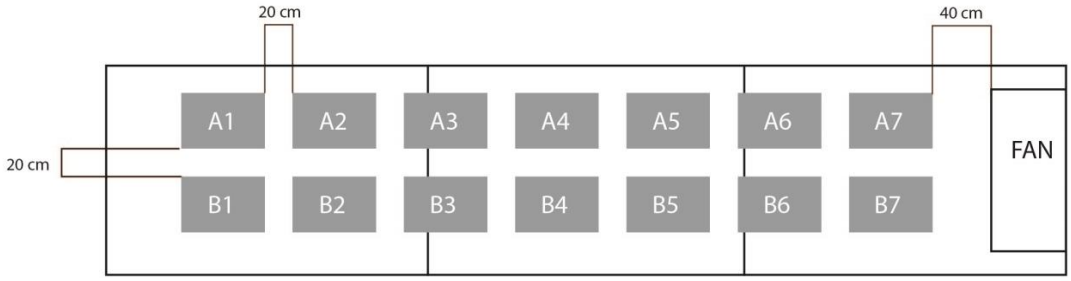


Figure 2: first cycle dryer configuration diagram

5. monitoring protocol
   a. Application of the monitoring protocol was conducted by two operators hired by VCF.
   b. 15 trays were selected and marked for daily monitoring (see diagram below).
   c. For more details please see Appendix A: AMAIZZ Fresh air dryer Pilot (Chili) – Layout, and Appendix B: AMAIZZ Fresh air dryer pilot (Chili) - monitoring protocol

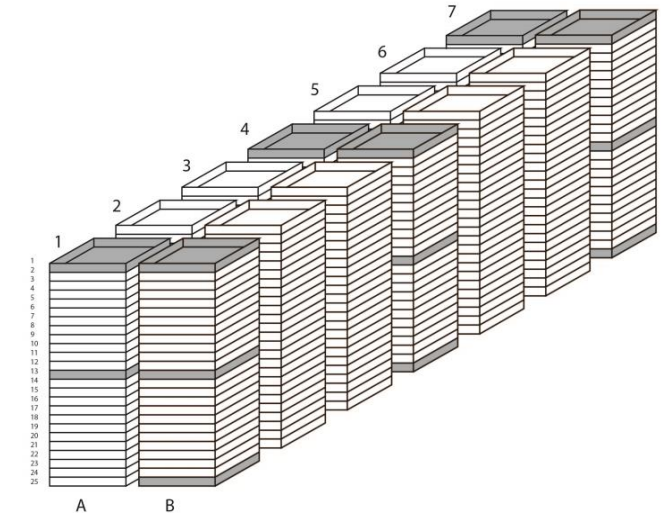


Figure 3: first cycle sample trays diagram

Table 4. First pilot – sample trays

Stack	1 (Top)	13 (Mid)	25 (Low)
A1	A1 1 (Top)	A1 13 (Mid)	-
A4	A4 1 (Top)	A4 13 (Mid)	-
A7	A7 1 (Top)	A7 13 (Mid)	-
B1	B1 1 (Top)	B1 13 (Mid)	B1 25 (Low)
B4	B4 1 (Top)	B4 13 (Mid)	B4 25 (Low)
B7	B7 1 (Top)	B7 13 (Mid)	B7 25 (Low)

F. First cycle results

1. Drying process

a. Weight loss (please note that on 6.1.19 at 17:00, data was not collected):

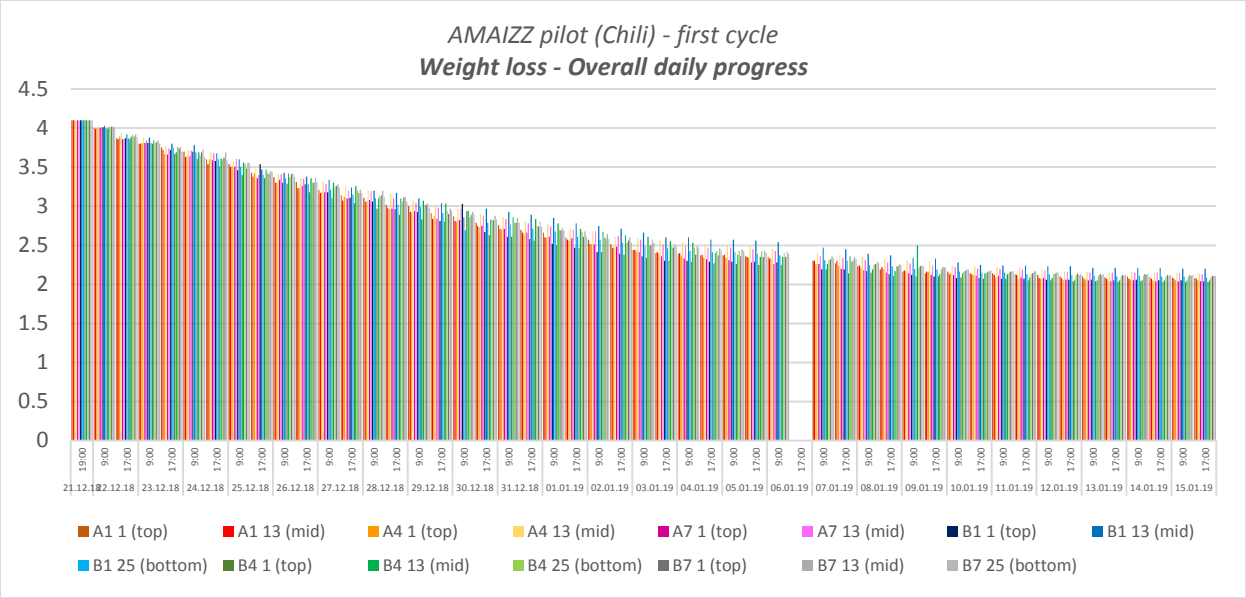


Figure 4: AMAIZZ pilot – first cycle weight loss progress

b. Average daily weight loss in row A was 0.078 Kgs, and in row B 0.077 Kgs. There was no segnificant differece found between weight loss in rows A and B, as can be seen in figures 5 and 6 below:

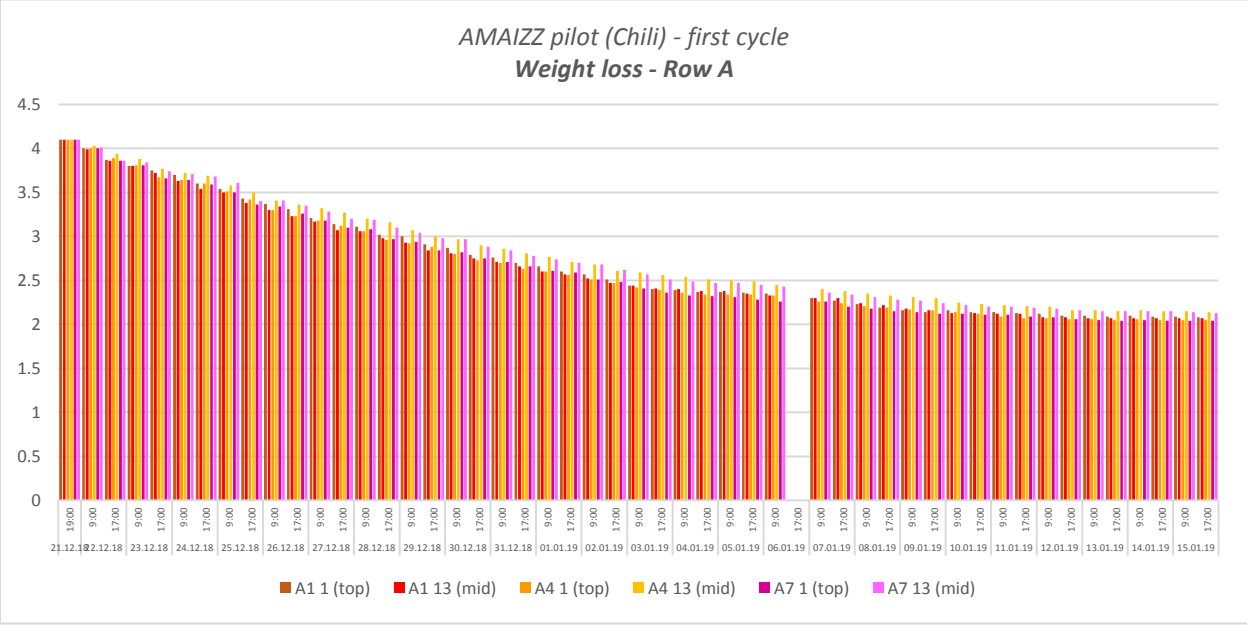


Figure 5: AMAIZZ pilot – first cycle weight loss progress in row A

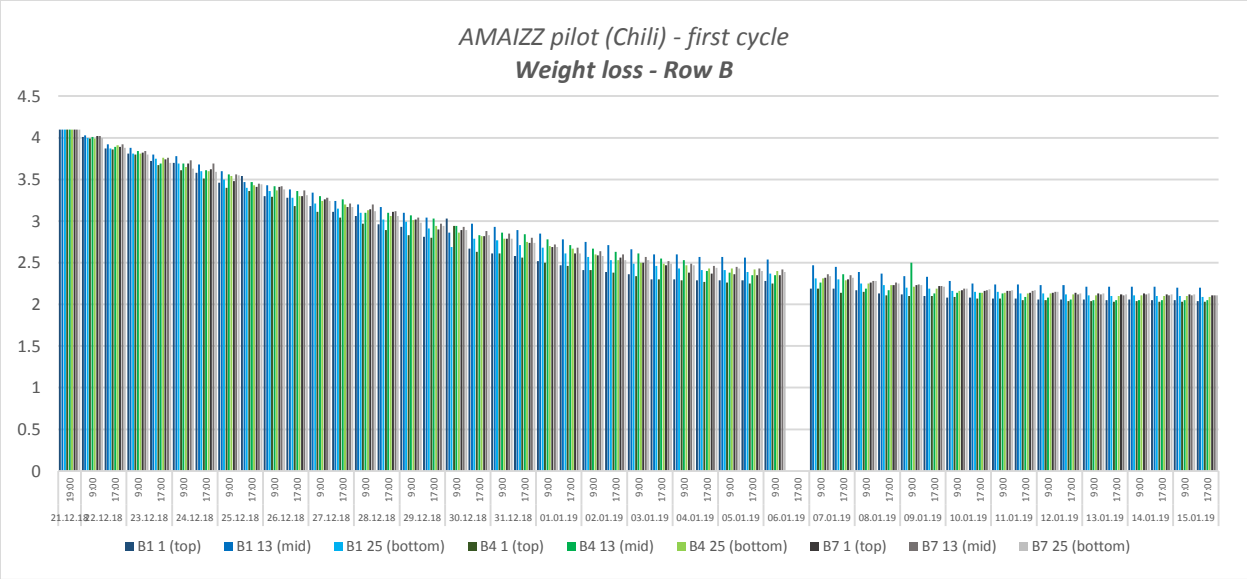


Figure 6: AMAIZZ pilot – first cycle weight loss progress in row B

c. As we can see in figure 4, though the general trend is simillar, there is a slight difference detected in daily average waight loss between the trays located in different hight within the stack, rather than between the rows. It seems that the weight loss rate was fastes in the top trays, followed by the bottom trays and lastly by the midle trays. This is conssistant with the fact that in a wind tunle/semi-wind tunnle structure, air suction is generaly stronger on the outer walls.
This can be seen in figure 5 (below), describing the avarage difference in daily weight loss, for each type of tray:

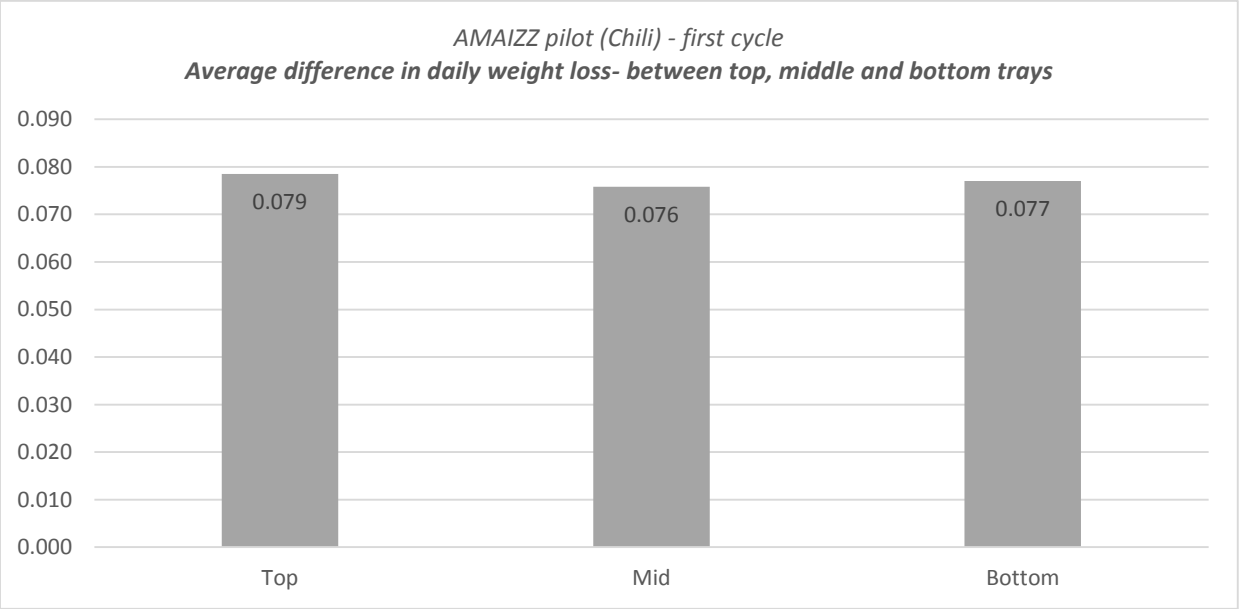


Figure 7: First cycle - Average difference in daily weight loss- between top, middle and bottom trays

d. Moisture test

Though moisture meter was availble on site, only few tests were made, and the results indicated there were either a result of a problem with the meter, or misuse of the meter by the opporators Therefore the data collected is unreliable, as can be seen in the moisture level test below (see figure 7). It is our view that this data should not be considured as a factor in the conclusions of this report.

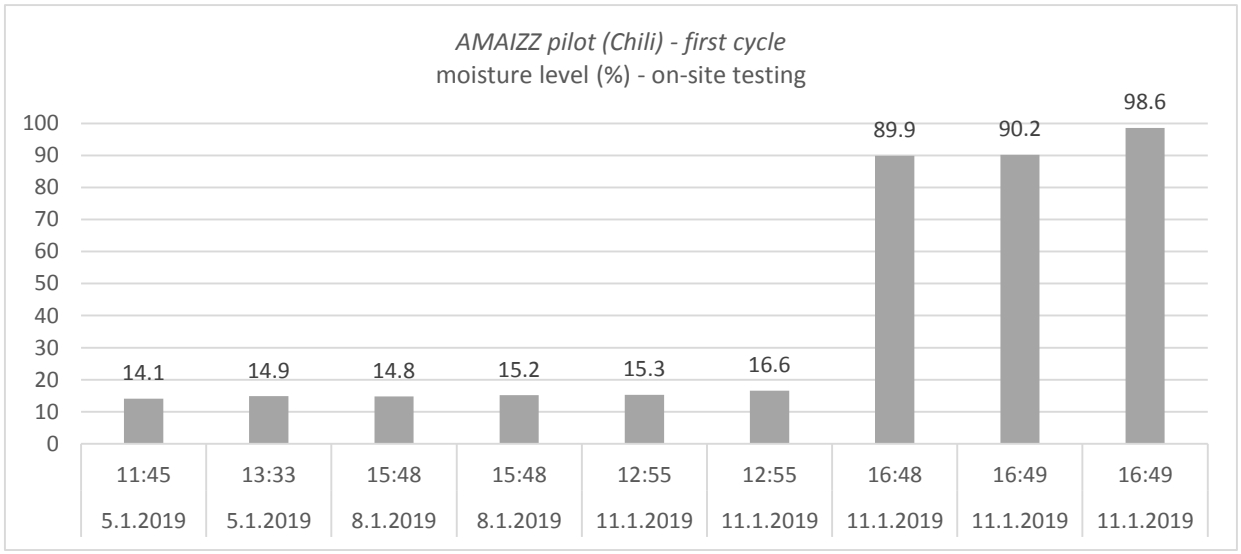


Figure 8: AMAIZZ pilot – first cycle daily moisture test conducted on-site

e. Electricity usage (based on pictures of the meter received via WhatsApp)

There were only 14 recordings of electricity usage in total (out of 52 requered for 26 days of use). Out of which there were only 2 days in which the monitoring was conducted twice (24.12.18, and 4.1.2019).

From the data recorded: the total electricity use was: 563.5 KWh, daily average was: 22.53 KWh.

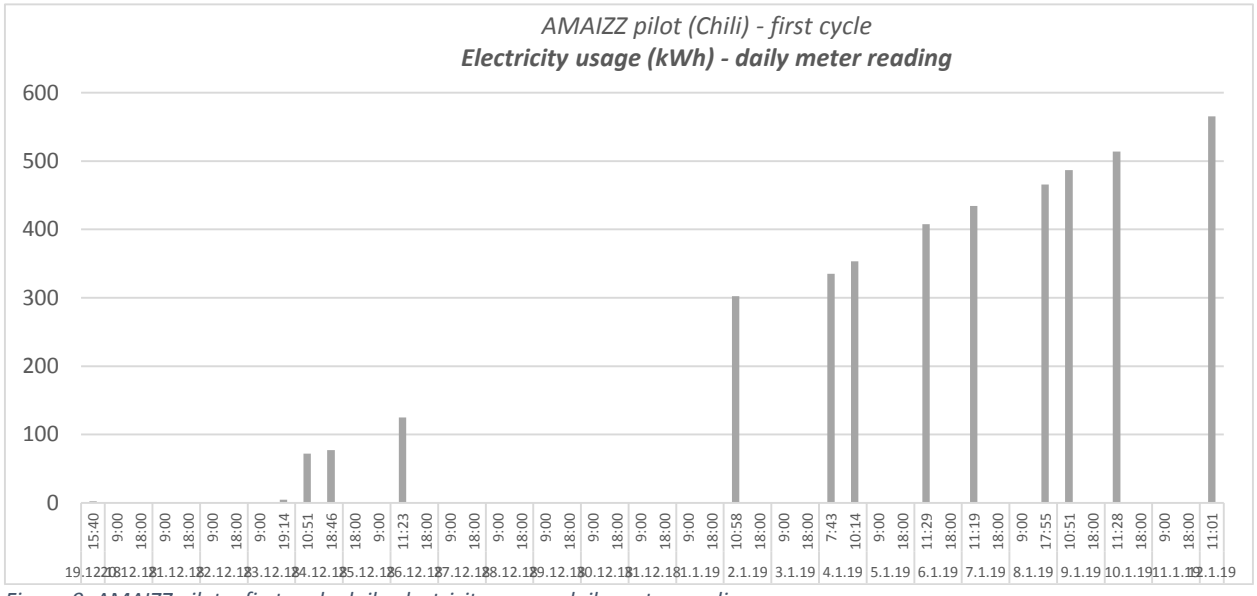


Figure 9: AMAIZZ pilot – first cycle daily electricity usage, daily meter reading

2. ***First cycle concluding results – produce assessment***

a. Final grading for all samples*:*

Table 5. Final grading (e-NAM market in Guntur)

Sample tray	Total ample weight (g)	Grade	Graded sample weight (g)	Moisture % (eNAM)	eNAM quality parameters	quality rating (eNAM - verbal)
A1(13) MID	140	High grade	90	12.3		
		Low grade	50	13.5		
B4(1) TOP	180	High grade	120	11.4	See table 6	third quality
		Low grade	60	13.9		
B4(13) MID	120	High grade	60	12.3		third quality
		Low grade	60	14.2		
B4(25) LOW	100	High grade	60	11.9		
		Low grade	40	13.1		
B7 (1) TOP	150	High grade	110	12.3		
		Low grade	40	13.3		
B7(25) LOW	120	High grade	80	13.5		
		Low grade	40	13.1		
Total	810	High grade (average)	520	12.28		
		Low grade (average)	290	13.52		
Control (18-19 days sun-drying)	220	High grade	220	10.5	See table 6	third quality

As can be seen in table 5, even though the sample from the control group went under a shorter period of drying, it contained lower moisture percentages than the treatment group samples, taken after 26 days of drying in the machine.

b. E-NAM market quality parameters test – comparing treatment and control sample:

Table 6. e-NAM market quality parameters test – comparing treatment and control samples

Test	Weight %		
quality Parameters	control	B4(1)	comments to parameters
good	63.49	79.18	
pod_5	80.35	83.46	full length
pod_3_5	4.17	6.01	half length
Pod without stalk	21.75	7.04	better without stalk
Broken	5.05	4.74	
Discolor	0	0	
Foreign Matter	5.28	2.08	
Loose seed	0.26	0.96	

The lab test results show that generally speaking, treatment group samples were of better quality. But, even though the treatment group scored better on all parameters, the difference in price arising from this gap is not significant, and is not estimated to result in more than 200 INR/quintal. Though this test may indeed be an indication of the advantages of an indoor drying facility, when taken together with the additional costs and a longer drying period, the increase in revenue in this case does not justify the trouble of using the machine. Furthermore, as the buyer of chili doesn't usually consider lab test results, even in the rare case of them being conducted, this gap in quality is not likely to be reflected in revenue with a standard purchase.

c. final quality distribution comparison between treatment and control groups:

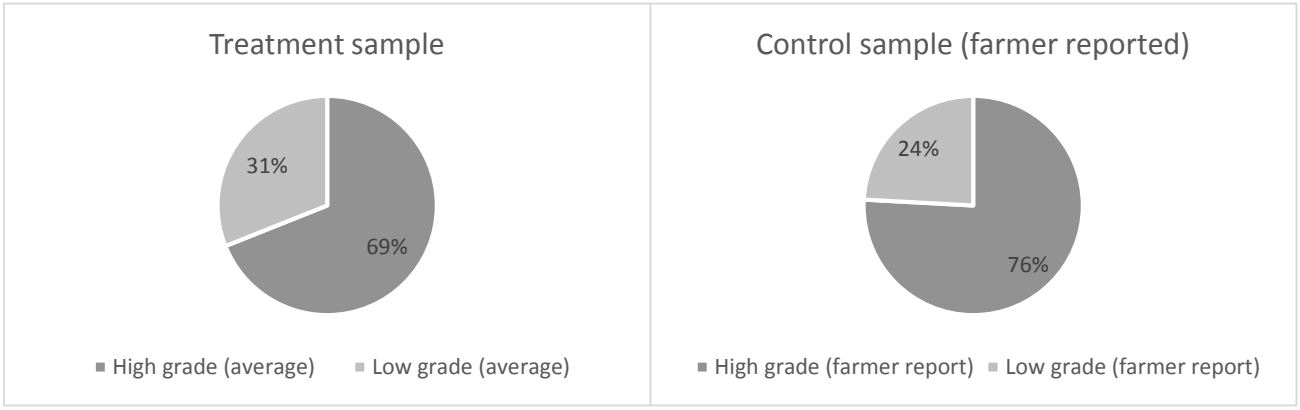


Figure 100: First cycle - Treatment and control groups quality distribution

In contrast with what was expected, the amount of low grade chili was higher in the treatment when compared to the control group. The reason for that is unclear, but it may be attributed to the longer drying time of the treatment group.

3. Expenses

a. Treatment group Expenses (paid by VCF)

Table 7. Treatment group Expenses summary

expense	amount	Rate (INR)	Total cost (INR)	comments
chili (Teja)	600 kg	0	0	farmer will receive the money after selling and will be compensated for any losses
Tractor (moving the produce from farmer's field to site)	1 tractor	700	700	
Workers for loading the dryer	2 workers	350 per worker, per day	700	
Workers for sorting the produce after drying (day 1)	5 workers	270 per worker, per day	1350	women workers are paid 270 INR vs man workers 350 INR per day

Workers for sorting the produce after drying (day 2)	3 workers	270 per worker, per day	810	
Electricity	563.3 KWh	Waiting for answer from market re: rate		Approximation: 2816.5 INR (5 INR/KWh). Electricity bill has not been paid yet
Rent	0	0	0	
Total			15,560	

It is important to clarify that the expenses descripted above are merely operational costs for this pilot, and are in no way reflective of the actual costs expected for operating a dryer in a "non-pilot" configuration. The reasons for that are many: first, the nature of work when operating a pilot is different to that of operating a commercial machine. Here, the many tests and scaling required two paid workers, while the number of workers needed to operate a commercial machine of the same capacity is unknown (AMAIZZ's personal estimate it to be one). Second, the size and capacity of the pilot dryer is different than that of a commercial one, and therefore expenses are expected to differ. As we could not get a clear idea of the commercial dryer's size if and when such a dryer would be purchased, the difference in price is hard to account for. Furthermore, fixed cost was not considered in this analysis, as there is no reason to assume similarity between the pilot model and a commercial one in this respect.

Never the less, we found it important to describe these expenses, as many of them will probably prove relevant with any dryer. But even more than that, the table illustrates the fact that even if the numbers will differ, any machine will bring with it a number of additional costs when compared with the traditional method. Highlighting this fact is important in cases like this, when, in light of the dryer's unsatisfactory results, any increase in the expenses is significant. Control group Expenses (paid by the farmer).

b. Data presented below is based on information received from the farmer during an interview conducted on 16.1.2019 (see appendix C: AMAIZZ Fresh air dryer pilot (Chili) - site visit 16-17.01.2019).

Table 8. Control group (sun-drying in farmer's field) Expenses summary

expense	amount	Rate (INR)	Total cost (INR)	comments
Workers for sorting the produce after drying (day 1)	15 workers	250 per worker, per day	3750	
Workers for sorting the produce after drying (day 2)	15 workers	250 per worker, per day	3750	
Workers for sorting the produce after drying (day 3)	10 workers	250 per worker, per day	2500	
Workers for sorting the produce after drying (day 4)	10 workers	250 per worker, per day	2500	
payment to buyer			700	per quintal for mediation (out of which 50 INR per

		quintal are for mediation), commission and transportation cost to the buyer
Total	13,200	

The big majority of the farmer's expenses when he is using the sun-drying method are due to labor for sorting the produce after drying. The reason this figure is higher in the control group, should be attributed to the fact that in this case, the control group contained significantly more produce. Generally, if the size of the groups is identical, so should be this figure: the work needed for any amount of chili, regardless of how it's dried, is the same.

4. Revenue

a. Treatment group revenue

1) The farmer completed his sun-drying process on 8.1.2019, and sold his produce more than a week before the treatment group produce was sold. In order to achieve good approximation, the produce was not be sold to the same vendor used by the farmer.
2) Final amount of dry produce: 232 kg

Table 9. Treatment group revenue summary

	Selling rate (INR/kg)	Dry Chili (kg)	Revenue (INR)
High quality	82	160	13120
Low grade	30	72	2160
Total	-	232	15280
Revenue per KG dry produce			65.86

b. Control group Income

Data presented below is based on information received from the farmer during an interview conducted on 16.1.2019 (see appendix C: AMAIZZ Fresh air dryer pilot (Chili) - site visit 16-17.01.2019).

Table 10. Control group revenue summary (farmer reported*)

	Selling rate (INR/kg)	Dry Chili (kg)	Revenue (INR)
High quality	78	2200	171600
Low grade	33	700	23100
Total	-	2900	194700
Revenue per KG dry produce			67.14

* Based on data received from the farmer (see appendix C: AMAIZZ Fresh air dryer pilot (Chili) - site visit 16-17.01.2019)

5. Profit

a. Treatment and control group income comparison

Table 11. Profit comparison (INR)

	Treatment	Control
Total expenses	3560	13200
Expenses per KG of dry produce	15.34	4.55
Total revenue	15280	194700
Revenue per KG of dry produce	65.86	67.14
Total profit	11720	181500
Profit per KG of dry produce	50.52	62.59

From tables 10, 11 and 12 we conclude that as result of the higher costs and lower revenue in the treatment group, the dryer holds no promise for the farmer in this configuration.

G. Second cycle overview

1. Treatment group
   a. Duration of second cycle: 9.2.19 – 25.2.19 (17 days total)
   b. Amount: 1,000 kg (all from 1 farmer)
   c. Variety: Teja Red Chili
2. Protecting the farmer: due to the problematic results of the first cycle and the unwillingness of other farmers to partake, it was decided that VCF will pay the farmer 10,000 INR for his participation in the pilot and to serve as a guarantee of sort.
3. Control group: control group of 1,000 kg was placed and dried in the farmer's field by the farmer.
4. Second cycle dryer configuration consisted of 3 rows, as shown in figure 10 below:

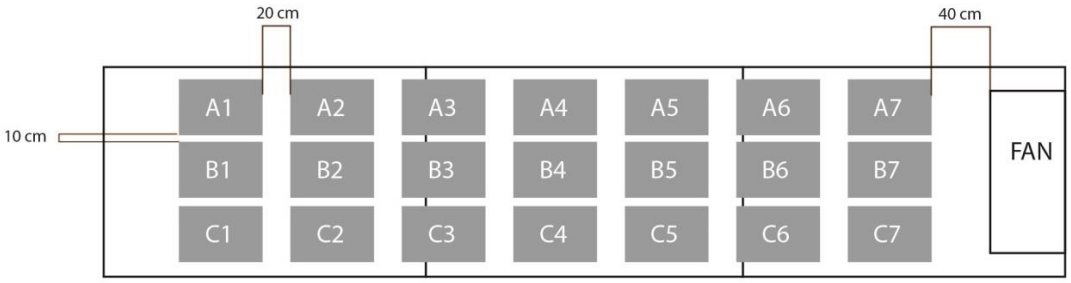


Figure 111: second cycle dryer configuration diagram

5. monitoring protocol
   d. Application of the monitoring protocol was conducted by the two operators hired by VCF.
   e. 21 trays were selected and marked for daily monitoring (see diagram below).
   f. For more details please see Appendix A: AMAIZZ Fresh air dryer Pilot (Chili) – Layout, and Appendix B: AMAIZZ Fresh air dryer pilot (Chili) - monitoring protocol

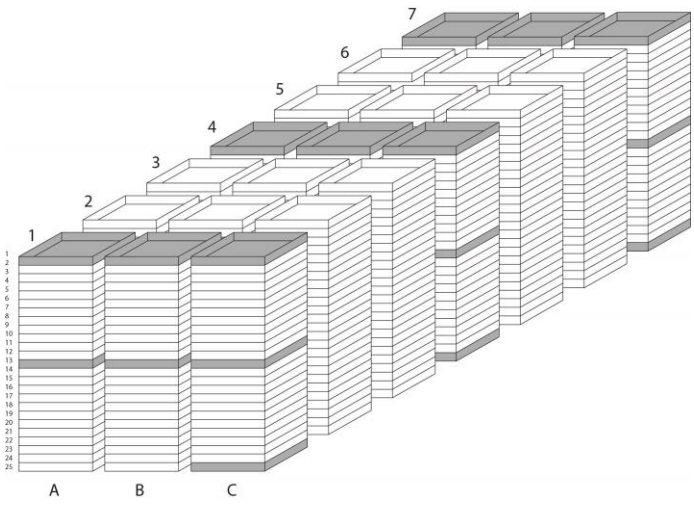


Figure 12: Second cycle sample trays diagram

Table 12. First pilot – sample trays			
Stack	1 (Top)	13 (Mid)	25 (Low)
A1	A1 1 (Top)	A1 13 (Mid)	-
A4	A4 1 (Top)	A4 13 (Mid)	-
A7	A7 1 (Top)	A7 13 (Mid)	-
B1	B1 1 (Top)	B1 13 (Mid)	-
B4	B4 1 (Top)	B4 13 (Mid)	-
B7	B7 1 (Top)	B7 13 (Mid)	-
C1	C1 1 (Top)	C1 13 (Mid)	C1 25 (Low)
C4	C4 1 (Top)	C4 13 (Mid)	C4 25 (Low)
C7	C7 1 (Top)	C7 13 (Mid)	C7 25 (Low)

H. Second cycle results

1. Drying process

a. Weight loss (*please note that on 9.2.19 at 17:00 and 10.2.19 data was not collected):

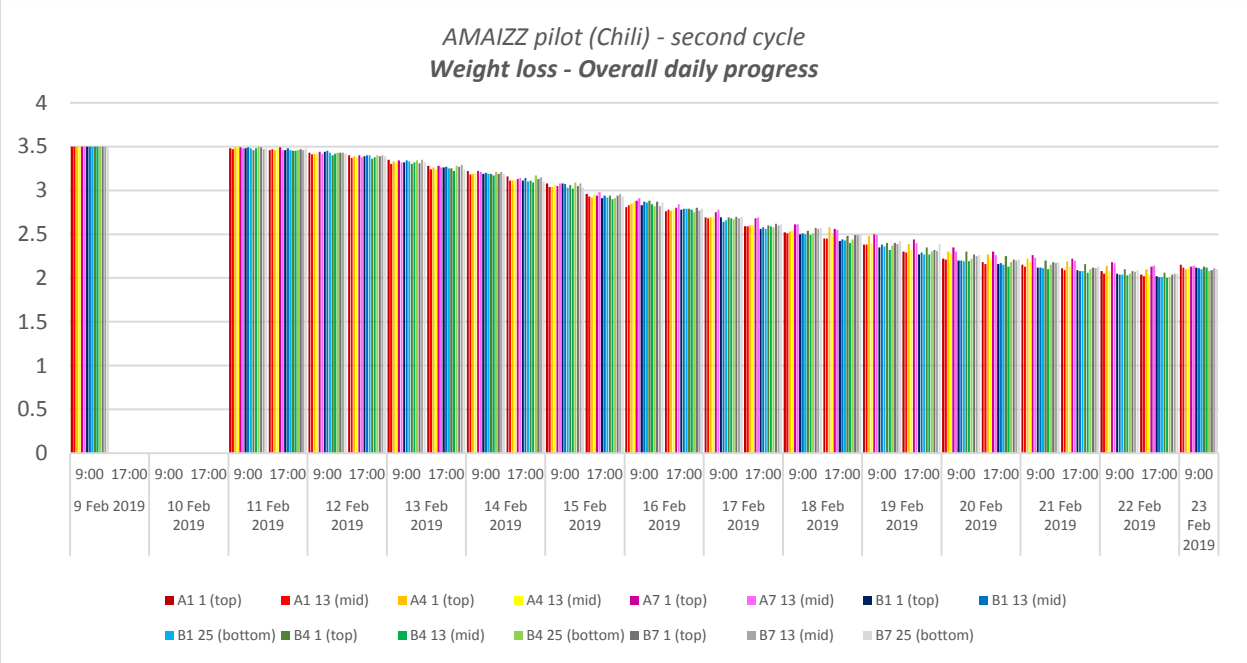


Figure 123: AMAIZZ pilot – second cycle weight loss progress

b. Differnces in wight loss progress between rows A and B: Similarly to the first cycle, there is no notble difference in weight loss between rows A and B, the average daily weight loss in row A was 0.081 Kgs, and in row B 0.082 Kgs (see figure 14 and 15 below)s. Unfortunatly there is no data for row C.

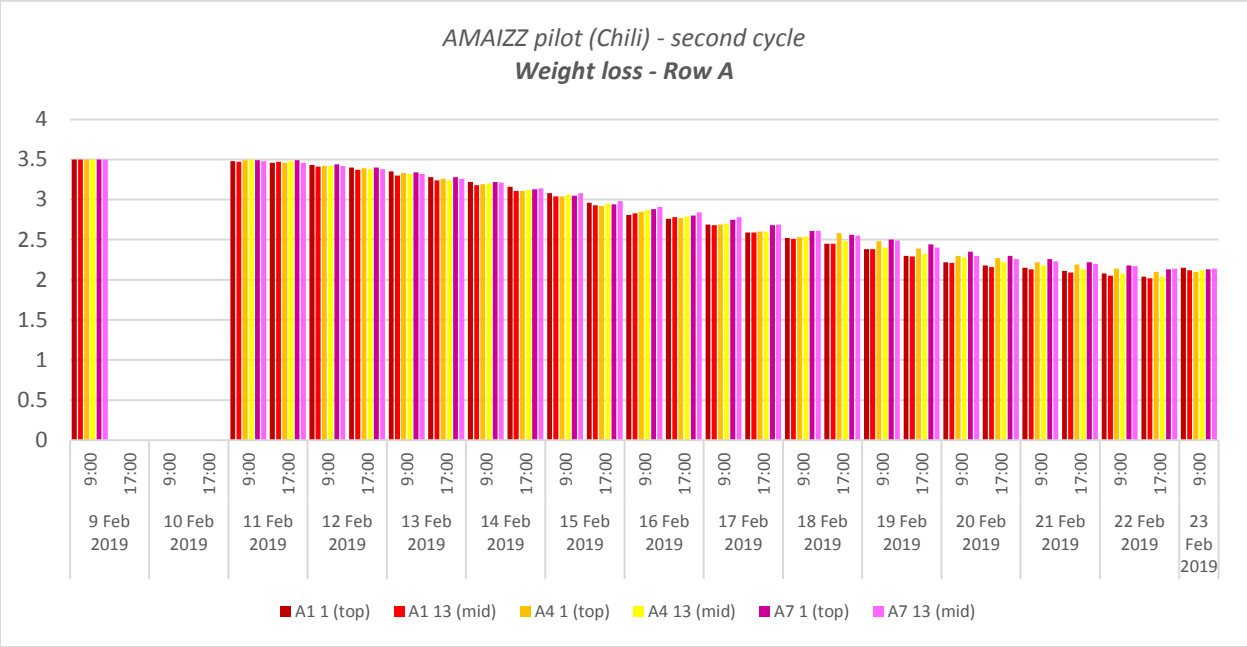


Figure 134: AMAIZZ pilot – second cycle weight loss progress in row A

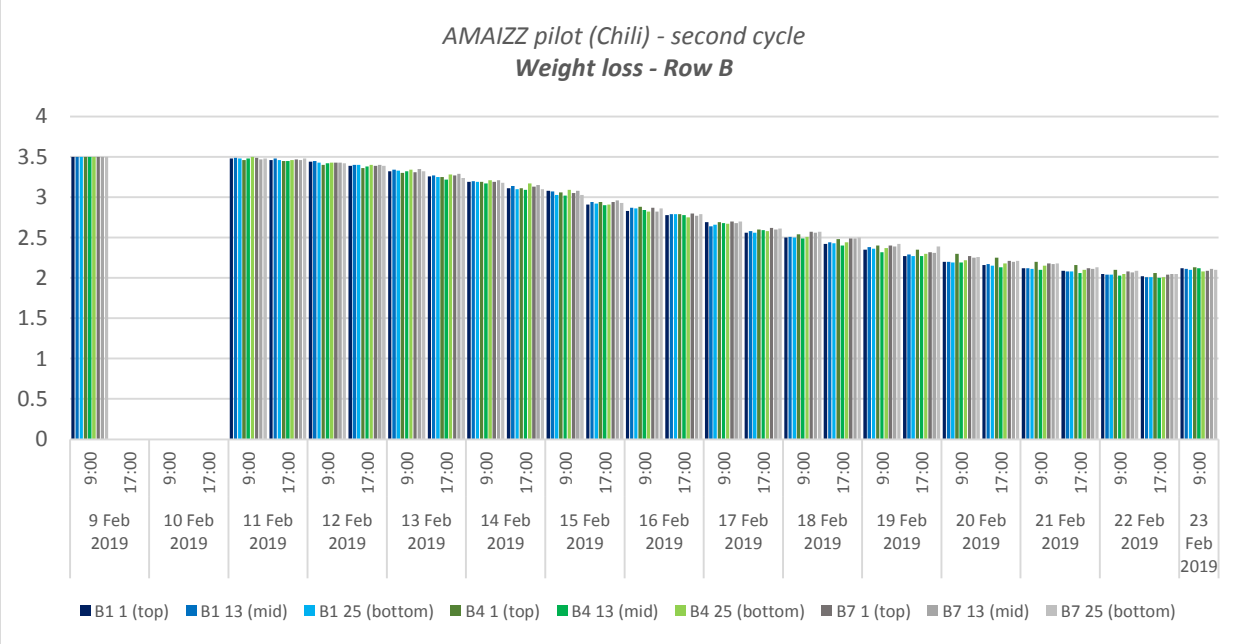


Figure 15: AMAIZZ pilot – second cycle weight loss progress in row B

c. Similarly to the first cycle there is a slight differece can see in figure 12, though the general trend is simillar, there is a slight difference detected in daily average waight loss between the trays located in different hight within the stack, rather than between the rows. This is again consistant with our expectation to have better air suction on the outer walls of the wind tunnle.

This can be seen in figure 15 (below), describing the avarage difference in daily weight loss, for each type of tray:

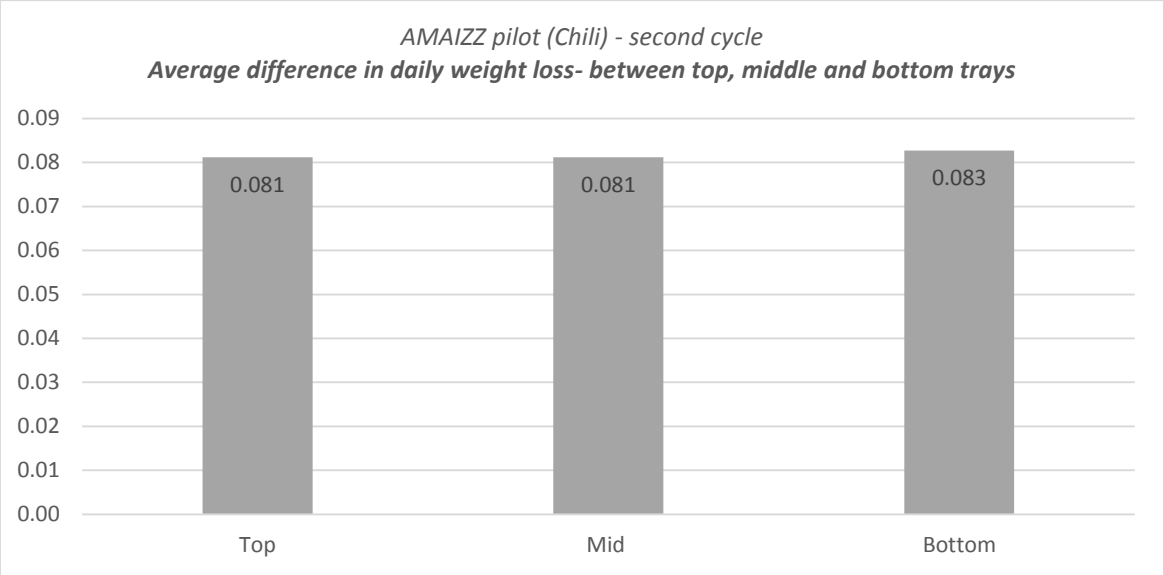


Figure 146: Second cycle - Average difference in daily weight loss- between top, middle and bottom trays

d. Moisture test

As there was no moisture meter availble on site for the secon cycle, only two tests were conducted in the treatment group and it is unclear from which tray or trays the sample was taken from. For the control group, only one test was recorded.

Table 13. **moisture level (%) - on-site testing**

Group	Date	Moisture tested (%)
Treatment	20 Feb 2019	15.24
Treatment	25 Feb 2019	9.48
Control	16 Feb 2019	14.6

e. Electricity usage (based on pictures of the meter received via WhatsApp)

There were only 7 recordings of the electricity usage in total (out of 34 requered for 17 days of use).

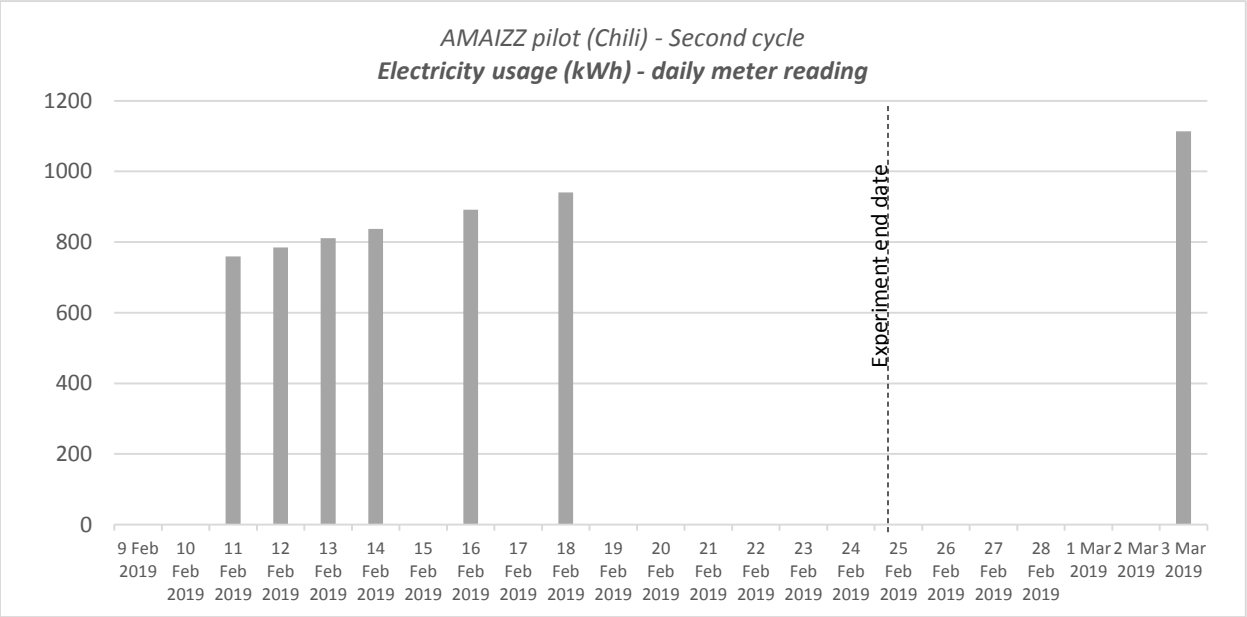


Figure 157: AMAIZZ pilot – second cycle Electricity usage (kWh) - daily meter reading

From the data recorded we can approximate that the total electricity use was: 353.8 KWh (note the data does not record exact start and end dates), and daily average was: 15.38 KWh.

2. ***Second cycle concluding results – produce assessment***
   a. The produce, both treatment and control, was not tested in the E-Nam lab, therefore the only comparison that can be made is based on market vendor grading and payment.

Table 14. Second cycle Summary

	Wet produce (kg)	dry produce(kg)	Drying time	Selling date
Treatment	1000	416	9-25.2.19	1.3.19
Control	1000	551.6	9-16.2.19	20.2.19

Table 15. Grading results

Group	Grade	Quantity (kg)
Treatment	High grade	366
	Low grade	50
Control	High grade	484.88
	Low grade	65.76

a. final quality distribution

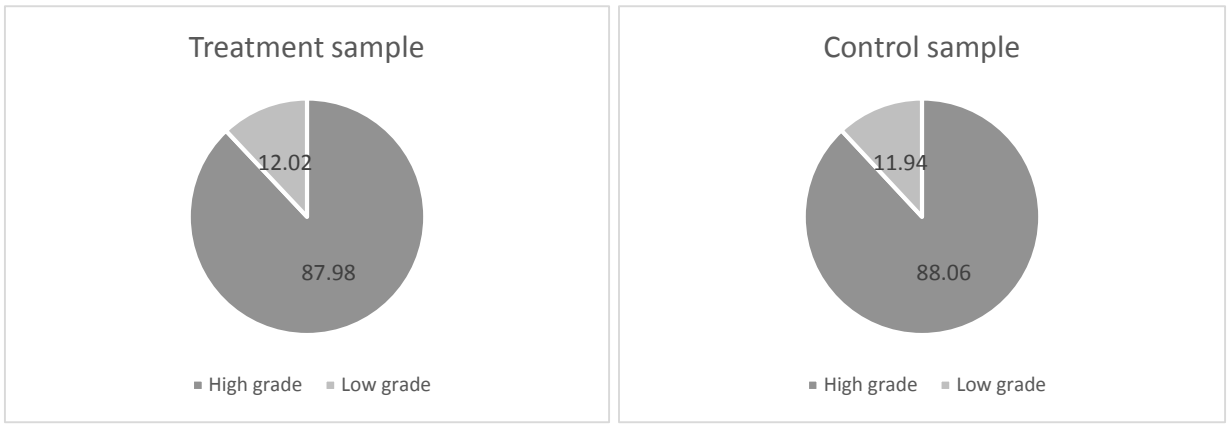


Figure 18: second cycle - treatment and control quality distribution comparison

On the second cycle, it seems like the distribution of high and low-grade chili within the two groups, though still leaning slightly in favor of the control group, are very similar and are of no substantial importance

3. Expenses

b. Treatment group Expenses (paid by VCF)

Table 7. Treatment group Expenses summary

expense	amount	Rate (INR)	Total cost (INR)	comments
chili (Teja)	2000 kg*	0	0	*for treatment and control
transportation			200**	**carrying the produce to the dryer
Workers for loading the dryer	0	0	0	
Workers for sorting the produce after drying (day 1)	7 workers	250 per worker, per day	1750	
Workers for sorting the produce after drying (day 2)	7 workers	250 per worker, per day	1750	
Electricity (KWh)	353.8	waiting for info	1769***	***approximation (5 INR/kwh): 1769
Rent	0	0	0	
Total			5469	

As mentioned before, it is important to clarify that the expenses descripted above are merely operational costs for this pilot, and are in no way reflective of the actual costs expected for operating a dryer in a "non-pilot" configuration. The reasons for that are many: first, the nature of work when operating a pilot is different to that of operating a commercial machine. Here, the many tests and scaling required two paid workers, while the number of workers needed to operate a commercial machine of the same capacity is unknown (AMAIZZ's personal estimate it to be one). Second, the size and capacity of the pilot dryer is

different than that of a commercial one, and therefore expenses are expected to differ. As we could not get a clear idea of the commercial dryer's size if and when such a dryer would be purchased, the difference in price is hard to account for. Furthermore, fixed cost was not considered in this analysis, as there is no reason to assume similarity between the pilot model and a commercial one in this respect.

Never the less, we found it important to describe these expenses, as many of them will probably prove relevant with any dryer. But even more than that, the table illustrates the fact that even if the numbers will differ, any machine will bring with it a number of additional costs when compared with the traditional method. Highlighting this fact is important in cases like this, when, in light of the dryer's unsatisfactory results, any increase in the expenses is significant. Control group Expenses (paid by the farmer).

c. Data presented below is based on information received from VCF team:

Table 8. Control group (sun-drying in farmer's field) Expenses summary

expense	amount	Rate (INR)	Total cost (INR)	comments
Workers for sorting the produce after drying (day 1)	8 workers	250 per worker, per day	2,000	
Workers for sorting the produce after drying (day 2)	8 workers	250 per worker, per day	2,000	
payment to buyer			0*	*No information
Total			4,000	

The big majority of the farmer's expenses when he is using the sun-drying method are for hired labor for sorting the produce after drying. The reason this figure is higher in the control group, should be attributed to the fact that in this case, the control group contained significantly more produce. Generally, if the size of the groups is identical, so should be this figure: the work needed for any amount of chili, regardless of how it's dried, is the same.

6. Revenue

a. Treatment group revenue
   1) Final amount of dry produce: 416 kg
b. Control group revenue
   1) The farmer completed his sun-drying process on 16.2.2019, and sold his produce more than a week before the treatment group produce was sold.
   2) To insure the same evaluation process was applied for all samples, the original plan was to sell the produce from both treatment and control to the same vendor from the first cycle. However, the farmer chose to sell the produce from the control group to a different vendor, for better rates (the difference in selling time can influence the price, and though the actual selling price of the produce was the same in control and treatment groups for high grade produce, and lower for the control low grade produce, it is entirely possible that for the selling date of the control group the rated were lower).
   3) Final amount of dry produce: 551.6 kg

Table 14. ***Revenue***

Group	Grade	Quantity (kg)	Price (INR/KG)	revenue	Total revenue	revenue per KG
Treatment	High grade	366	80	29280	30,530	73.39
	Low grade	50	25	1250		
Control	High grade	484.88	80	38790.4	40,105.6	72.83
	Low grade	65.76	20	1315.2		

7. Profit

a. Treatment and control group income comparison

Table 15. ***Profit comparison (INR)***

	Treatment	Control
Total expenses	5469	4000
Expenses per KG of dry produce	23.57	1.38
Total revenue	30530	40105.6
Revenue per KG of dry produce	131.59	13.83
Total profit	25061	36105.6
Profit per KG of dry produce	108.02	12.45

From tables 16 and 17 we conclude that as result of the higher costs and lower revenue in the treatment group, the dryer holds no promise for the farmer in this configuration.

8. conclusions

In conclusion, it seems that even though post-harvest losses and damages are an acute problem for many small-holder chili farmers, the AMAIZZ fresh-air dryer does not provide a sufficient solution in addressing it.

The first and main reason for that is, undoubtedly, the fact that the dryer did not show any substantial promise in increasing the small-holder chili grower's net income. While the expenses when using the machine are generally higher (due to transportation costs, labor costs, electricity costs, operation costs etc.) in comparison with traditional methods, the increase in revenue is either negligible or negative. Even though the expenses of machine drying as they appear in this report are hardly reflecting the expected expenses of a "real-life" or a "non-pilot" dryer, it is far from reasonable to assume they will not exceed the expenses bore by a farmer using the traditional method significantly.

In contrast with what was expected, no real evidence of the fresh-air dryer expediting the drying process was found during the pilot. In both cycles, it seems that even though fresh-air drying took longer, moisture levels was higher in comparison with the control group. Other parameters of quality, however, proved to be slightly higher in the treatment group, but the increase in revenue resulting from that gap was very far from justifying considering the machine as a replacement for the farmer's own practices.

In the second cycle, even though the treatment produce was sold later and therefor contained significantly lower moisture percentages (less than 10%, in comparison with about 14% in the control group), the net revenue out of it was lower. This fact is difficult to account for, but it seems that high quality produce from both groups was priced equally, with no compensation for lower moisture levels. It may be explained by the fact that in this cycle the produce was not brought to E-NAM for accurate scientific evaluation, but rather was sold to a local vendor grading the chili "by hand". If that is the case, it is easy to see why the same number of chilies, will produce less revenue when dryer and therefor lighter. Even so, the increase in quality and/or decrease in moisture level in the treatment group did reflect on the price of the lower grade chilies, which was 500 INR/quintal higher in comparison with the control group. But, as we can see, this increase was not enough to change the net balance in favor of the treatment produce. Furthermore, this increase in price doesn't necessarily indicate a causal connection between it and the discussed parameters, as the two groups of produce were sold at a different time, and market prices for chili may vary quickly.

Finally, it is worth mentioning that the interaction between AMAIZZ LTD and Tata-Trusts was far from smooth, both before and during the pilot. Though it is not uncommon for a first tech-pilot, in any field, to introduce some unexpected challenges, it seems like the scope of problems emerged in this experiment was beyond reasonable. This is true not only because of the large number of obstacles that arose along the way – a figure which is difficult to forecast before actually piloting - but mostly because of their nature: many of them, so it seems, could have been avoided if a more rigorous planning process and a more transparent communication channel was to take place. Without going into all of the relevant details (which can be found on Appendix D: AMAIZZ Fresh air dryer installation – inquiry), the main issues resulting from the above are: A) Out of the two dryers that were supposed to be piloted, only one was assembled. This was a result of AMAIZZ's technician's lack of knowledge regarding some of the second dryer components, as well as an unrealistic time schedule for the assembly of both machines. B) Some major gaps were found between the expected capacity of the dryers and their actual capacity, as well as between the model designs that were shared in advance and the machines on the ground. Though the reason for the latter is still somewhat unclear, it is safe to say that the first gap resulted from lack of planning, as the calculations needed to come up with a more realistic estimation are simple and straight-forward. C) The fact that the pilot should include a "pre-pilot" to determine the optimal drying capacity of the machine was not communicated in advance, which resulted in a significantly longer experiment duration needed in order to properly evaluate the technology. As a result, and together with a much-longer-drying-period within the dryer than was anticipated, the chili season only allowed for two drying cycles, which are far from optimal even for the evaluation of the dryer's efficient capacity.

These points, taken together with the fact that no real indications for the potential of the dryer to increase the small-holder chili farmer net income were found, are leading us to the conclusion that the search for a technological solution for post-harvest loses in chili should, for the time-being, continue.

List of appendixes:

a. Appendix A: AMAIZZ Fresh air dryer Pilot (Chili) - Layout
b. Appendix B: AMAIZZ Fresh air dryer pilot (Chili) - monitoring protocol
c. Appendix C: AMAIZZ Fresh air dryer pilot (Chili) - site visit 16-17.01.2019
d. Appendix D: AMAIZZ Fresh air dryer installation - inquiry

Appendix A: AMAIZZ Fresh air dryer Pilot (Chili) – Layout

8 January, 2019

2 Stages:
Pre-pilot (4 trails for each variety)
Pilot (full capacity, multiple farmers)

Pre-pilot
Objectives:

1. Determine optimal loading layout for the fan dryer in different types of chili, including spacing and capacity.
2. Determine optimal drying time for different types of chili.
3. Quality assessment for all dried produce and control produce in different types of chili
    a. Field testing (meter and digital scale).
    b. E-NAM market lab testing.

Pre-pilot design
Produce:
First 4 trials will include one type of Chili – most common in Durgi area, preferably from one farmer (depending on availability of produce).

The pre-pilot will include 4 trial runs as follows:

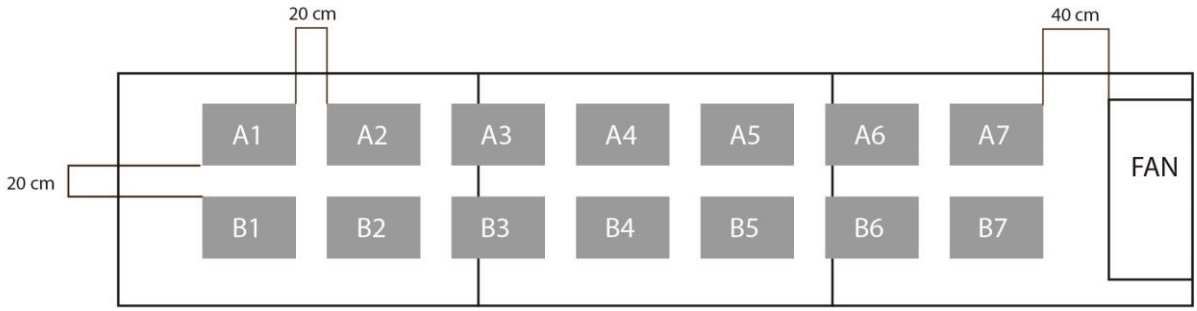
Trial	Amount of chili (kg)	Layout
1	600	• 2 rows • Loading: stacks A1,A2,A4,A7,B1,B2,B4,B7 (Full) • 3 kg per tray
2	~1,000	• 2 rows • Loading: All stacks (14) • 3 kg per tray
3	~1,000	• 3 rows • Distributed through all 21 tray stacks • 15-17 trays per stack of 25 trays filled with produce, and the rest empty
4	~1,500	• 3 rows • Loading: full capacity (all 525 trays filled with produce)

Layout inside dryer 2 rows (350 trays):

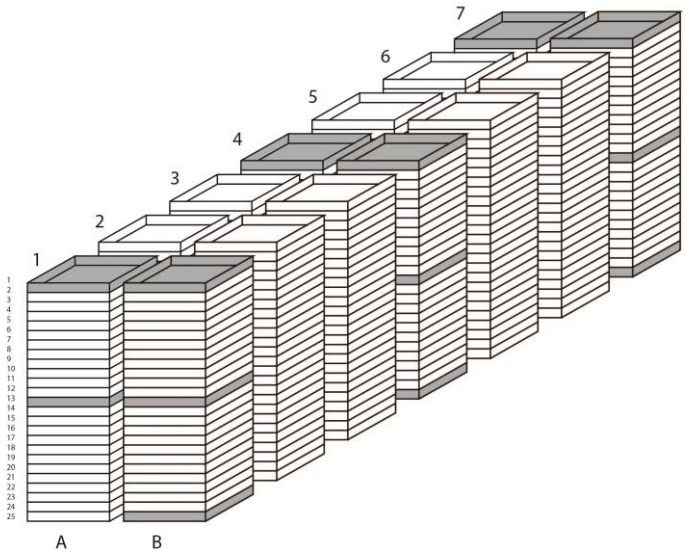
Estimated capacity:
25 trays in each stack
Tray capacity ~3 kg
Total capacity ~ 1,050 kg (~1 Ton)

Spacing (see diagram above):
40 cm between fan and firs tray stacks.
20 cm between tray stacks in one row.
10-20 cm between rows.

Layout inside dryer 2 rows (350 trays) diagram:



Sampling trays



Sample trays: 15 total

Stack	1 (Top)	13 (Mid)	25 (Bottom)
A1	A1 1 (Top)	A1 13 (Mid)	-
A4	A4 1 (Top)	A4 13 (Mid)	-
A7	A7 1 (Top)	A7 13 (Mid)	-
B1	B1 1 (Top)	B1 13 (Mid)	B1 25 (Bottom)
B4	B1 1 (Top)	B1 13 (Mid)	B1 25 (Bottom)
B7	B1 1 (Top)	B1 13 (Mid)	B1 25 (Bottom)

Layout inside dryer 3 rows (525 trays):

Estimated capacity:
25 trays in each stack
Tray capacity ~3 kg
Total capacity ~ 1,575 kg (~1.5 Ton)

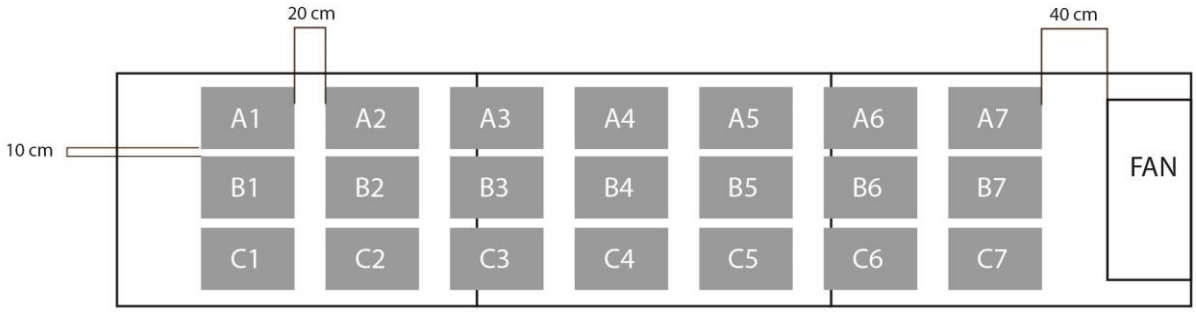
Spacing (see diagram below):

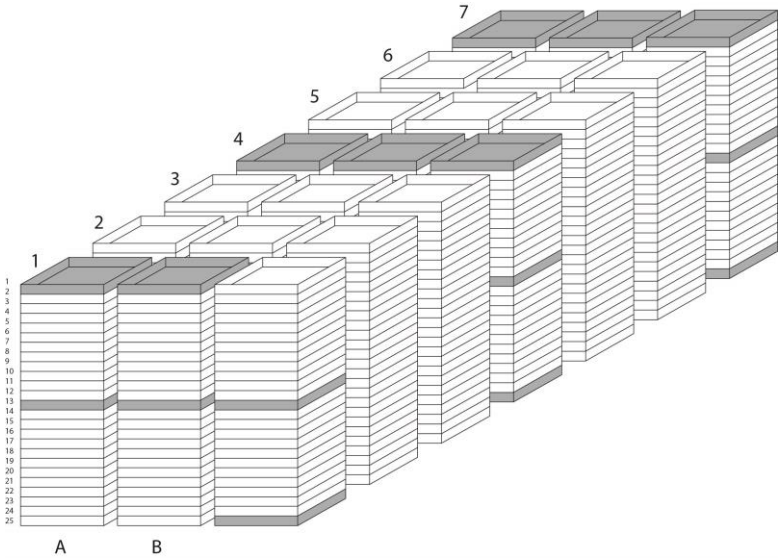
Stack	1 (Top)	13 (Mid)	25 (Bottom)
A1	A1 1 (Top)	A1 13 (Mid)	-
A4	A4 1 (Top)	A4 13 (Mid)	-
A7	A7 1 (Top)	A7 13 (Mid)	-
B1	B1 1 (Top)	B1 13 (Mid)	B1 25 (Bottom)
B4	B1 1 (Top)	B1 13 (Mid)	B1 25 (Bottom)
B7	B1 1 (Top)	B1 13 (Mid)	B1 25 (Bottom)

40 cm between fan and firs tray stacks.
20 cm between tray stacks in one row.
10 cm between rows.

Estimated capacity:
25 trays in each stack
Tray capacity ~3 kg
Total capacity ~ 1,575 kg (~1.5 Ton)

Layout inside dryer 2 rows (525 trays) diagram:
Sampling trays:





Sample trays: 15 total

Dryer Monitoring protocol

Steps:

A. Before loading the dryer

1. Weigh and take picture of all produce received, per farmer.
2. Fill "initial report".
3. Distribute produce in trays as specified per trial (see above).
4. For all ample trays, marked with white ribbon (see diagram below):
    a. Weigh each tray with produce
    b. Measure humidity
    c. Take picture of tray with produce (make sure the serial number of the tray and produce are visible)
5. Fill first "Daily data collection report"

B. Ongoing data collection

a. 2 times every day
    - Morning 09:00
    - Evening 17:00
b. Total sample trays:
    - from each row: 3 stacks (top middle and bottom)
    - from stacks: 3 (front, middle and back)
c. Moisture check and picture.

Sample trays diagram:

6. When produce is sufficiently dry (8-12%) - transfer produce to E-NAM market, in presence of farmer.
7. Receive lab analysis report, and market price for the produce (recorded in app and hard copy)

Equipment required for monitoring:

1. Smart phone
2. Digital scale
3. Moisture meter
4. Sticker/ribbon for marking the trays
5. Printed copy of protocol and reports
6. Protected gear: face mask and gloves

Data collection

1. Initial report
2. Daily data collection
3. Electricity report
4. Concluding report

Appendix B: AMAIZZ Fresh air dryer pilot (Chili) - monitoring protocol

Last version: 8 January, 2019

Bellow are all the forms necessery for the monitoring protocol for the AMAIZZ Fresh air dryer pilot with Chili (printout version is also availble):

A. Dryer data collection (monitoring protocol)

Dryer (Blower) Monitoring Protocol – Initial report

Date and time	
Name of farmer	
Telephone number	
Village	
Verity	
Number of bags	
Total weight	
Initial moisture test (from first daily recording)	
Picture (on tarp)	

Dryer (Blower) Monitoring Protocol – Daily report

Farmer's name	Telephone number	Verity	Initial quantity (kg)	Start date

Date	Time	Stack	A7		A4		A1		B7			B4			B1		
		Tray	1	13	1	13	1	13	1	13	25	1	13	25	1	13	25
	09:00	Weight (kg)															
		Moisture %															
	17:00	Weight (kg)															
		Moisture %															
	09:00	Weight (kg)															
		Moisture %															
	17:00	Weight (kg)															
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	09:00	Weight (kg)															
		Moisture %															
	17:00	Weight (kg)															
		Moisture %															

Dryer (Blower) Monitoring Protocol – Power-cut report

Power-cut start		Power-cut start			Power-cut start		Power-cut start	
Date	Time	Date	Time		Date	Time	Date	Time

Dryer (Blower) Monitoring Protocol – concluding report

Date and time (at E-NAM)		
Name of farmer		
Telephone number		
Village		
Verity		
Number of bags (dry produce)		
Total weight (dry produce)		
Drying time (days)		
Grade A	Amount (kg)	
	Moisture %	
	price	
	picture	
Grade B	Amount (kg)	
	Moisture %	
	price	
	picture	
Grade C	Amount (kg)	
	Moisture %	
	price	
	Picture	
Scan E-NAM lab report		
Scan receipt		

B. Control sample data collection (monitoring protocol)

<u>Details:</u>

Matching amount of produce will be dried as a control sample, on a separate tarp in the field of the farmer.

The farmer will be dried in traditional methods by the farmer, and 3 trays (same as the ones used for the dryer) will be placed nearby. The sample will be monitored by a designated person employed by VCF.

Control sample Monitoring protocol:

1. Weigh and take picture of all produce received.
2. After the farmer spreads the produce on the tarp take a picture and record moisture % (recorded in app and hard copy).
3. weekly moisture check – (recorded in app and hard copy):
    a. Same day and time
4. When the farmer decides the produce is sufficiently dry - transfer produce to E-NAM market, in presence of farmer.
5. Receive lab analysis report, and market price for the produce (recorded in app and hard copy)

Equipment required for monitoring:

1. Smart phone
2. Digital scale
3. Moisture meter
4. Tarp with marking
5. Printed copy of protocol and reports

Reports:

Initial report:

Date and time	
Name of farmer	
Telephone number	
Village	
Verity	
Number of bags	
Total weight	
Initial moisture test (from first daily recording)	
Picture (on tarp)	

Weekly data collection:

Week	Date	time	Moisture %	picture	Questions for the farmer:		
1 initial					Work in field	What did you do during the week to dry the chili (removing rotten ones, turning, other)	
					Hired labor	How many workers did the farmer hire?	
						For how many days were they hired?	
						What was the total cost hired labor this week?	
					Farmer	How many days did you work in the field	

						How many hours in average each day?	
					Other HH members	How many of you HH members worked in the field this week?	
						How many hours in average each day?	
					produce	How many were lost?	
2					Work in field	What did you do during the week to dry the chili (removing rotten ones, turning, other)	
					Hired labor	How many workers did the farmer hire?	
						For how many days were they hired?	
						What was the total cost hired labor this week?	
					Farmer	How many days did you in the field	
						How many hours in average each day?	
					Other HH members	How many of you HH members worked in the field this week?	
						How many hours in average each day?	
					produce	How many were lost?	
3 last					Work in field	What did you do during the week to dry the chili (removing rotten ones, turning, other)	
					Hired labor	How many workers did the farmer hire?	
						For how many days were they hired?	
						What was the total cost hired labor this week?	
					Farmer	How many days did you in the field	
						How many hours in average each day?	
					Other HH members	How many of you HH members worked in the field this week?	
						How many hours in average each day?	
					produce	How many were lost?	

Concluding report:

Date and time (at E-NAM)	
Name of farmer	
Telephone number	
Village	

Verity		
Number of bags (dry produce)		
Total weight (dry produce)		
Grade A	Amount (kg)	
	Moisture %	
	price	
	picture	
Grade B	Amount (kg)	
	Moisture %	
	price	
	picture	
Grade C	Amount (kg)	
	Moisture %	
	price	
	Picture	
Scan E-NAM lab report		
Scan receipt		

Appendix C: AMAIZZ Fresh air dryer pilot (Chili) - site visit 16-17.01.2019

Amaizz fresh air dryer

Start date: 21.12.19 (26 days so far)

Amount: 600 kg (from 1 farmer)

Variety: Teja

Farmer's name: Unaraw Reddy

Field size: 3 acres

Objectives:

1. Determining exact moisture level: samples from 3 trays- B1(2), B4(2), B7(2) + sample from farmers field to be tested in oven drying test
2. Interview farmer on his drying practices and costs
3. Prepare next load including control sample
4. Update monitoring protocol according to next load

16.1.2019

Observations:

1. The chili is dry according to the farer's estimation.
2. There is a lot of dust on the chili.
3. The controller was found in the heat pump.
4. Colleges and the market are closed due to festival, therefore oven drying testing is not possible today.

Figure 16: tray B1 (4)

Plans for currant and second trial

Plans for sorting and selling first batch:

1. Tomorrow 3-4 workers will come to do the sorting on site.

2. We need to contact the local vendor (same method as farmers produce) to see if he is willing to buy from us.
3. If local buyer not interested we can take the produce to the market.
4. We can take the produce to the market on Friday 18/1/2019 (after sorting)
5. Because we are approaching the weekend the produce will be stored and actioned on Monday 21/1/2019 (according to the farmer and Mr. Veerabhadra this will not damage the produce.

Plans for loading second batch:

1. We will purchase 1 ton from a different farmer, same verity.
2. Tomorrow we will finalize the schedule according to produce availability.
3. If possible, planning to load tomorrow 2nd load.
4. 3-4 workers will come to load the drier on site.

Interview with the farmer:

When did you complete the drying process?

8.1.2019

How long did it take?

20 days

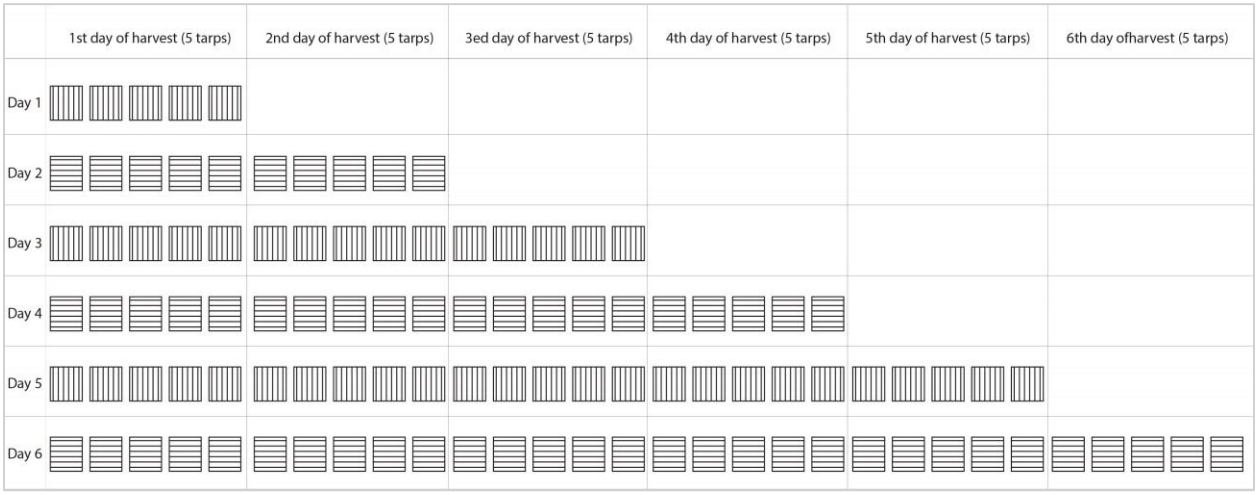
How much produce did you dry?

- The farmer is not sure what was the exact amount harvested (he did not scale the produce before drying).
- He estimated about 25 quintal yield per acre in average.
- He sold:
    - 22 quintal high grade = 7,800 INR per quintal
    - 7 quintal low grade (and rotten ones) = 3,300 INR per quintal
    - (+600 kg used by us)

What was the method of drying? What are the steps?

1. 6 days for harvest – 5 tarps each day
2. Level the land and place tarp
3. Harvest and place on tarp (he had total of 29 tarps, placing a thin layer during this time because of climate condition, in February he will use less tarps), level the produce
4. Every day he adds a new tarp and plows rows with his legs – different directions on alternate

Sun-drying days diagram:



Did you separate the produce (grading)?

- Yes, before selling.
- Used 50 workers in total for this process (250 INR per day, per worker)
- Time for separating: 4 days (first day: 15, second day: 15, third day: 10, fourth day: 10)

How much produce was lost during grading process?

- 30% low grade and rotten.
- Claims almost all the produce, including rotten and discolored was sold (low grade includes spoilt produce)
- 5-10 kg for family consumption

To whom did you sell?

Buyer from the village

What was the price in market?

- High grade = 7,800 INR per quintal
- Low grade = 3,300 INR per quintal

What was the cost of labor for drying?

- Harvest: 3 acres, 325 labors for harvest, 150 INR for each worker per day = **48,750** INR
- Grading: 50 workers after drying, for sorting 250 INR for each worker per day = **12,500** INR
- Ongoing:
    - Every day 1 hour he worked in the field for turning the chili (not separating damaged chilies)
    - When it was raining he was helped by another farmer- not paid

What was the cost of transportation to the market?

- The buyer came to the market and took the produce.

- Payment to buyer: the farmer paid **700** INR per quintal for mediation (out of which 50 rs per quintal are for mediation), commission and transportation cost to the buyer
- The farmer thinks he would get 800 INR more per quintal if he would go to the market himself, but the transport cost would be approximately 700 INR per quintal, so the difference will not be high)

Were there any additional costs? What were they?

None.

Grading and pricing:

Before the buyer comes the farmer grades his produce based (estimate by touch and color, based on experience). Then he calls the market to check the prices of different grades, accordingly he negotiated the price.

How does the farmer estimate the produce dried in the dryer in comparison with sun drying traditional method?

- In the dryer – there is less discoloration and the discolored ones are not fragile (as they usually are in traditional method).
- The farmer estimated we will have more discoloration because we kept the produce in the drier one week too long.

Conclusions:

1. We need a more reliable method to check for humidity during the drying period.
2. The farmer should visit the site regularly and assess the progress.
3. It's possible the produce was sufficiently dry at the same time as the farmer's – this should be confirmed in comparison with market prices and lab testing.
4. There should be a control sample monitored in a similar manner, as was planned initially.
5. The selling of the produce used for the pilot should be as similar to the farmer's method as possible.
6. We need to determine who bares the costs and how.

17.1.2019

Progress

1. The second batch will not be loaded today as the harvest has not taken place (postponed to 18/1/19).
2. The sorting process takes longer than planned and will be completed the following day (18/1/19).
3. Samples from selected trays were taken to e-NAM lab in Guntur for testing.

Grading process:

- 5 workers sorting the chili from the machine (09:00-17:00) = 250 per worker, per day
- Sorting includes dividing the produce into 2 categories:
    - High grade: bright red, un-broken chilies.
    - Low grade: discoloration, fungi or infections, broken chilies.

Figure 17: sorting the produce

e-NAM market in Guntur - visit summary

1. Testing in e-NAM facility
    a. Moisture% tested in e-NAM lab:

Sample tray	Total ample weight (g)	Grade	Graded sample weight (g)	Moisture % (e-NAM)
A1(13) MID	140	High grade	90	12.3
		Low grade	50	13.5
B4(1) TOP	180	High grade	120	11.4
		Low grade	60	13.9
B4(13) MID	120	High grade	60	12.3
		Low grade	60	14.2
B4(25) BOTTOM	100	High grade	60	11.9
		Low grade	40	13.1

B7 (1) TOP	150	High grade	110	12.3
		Low grade	40	13.3
B7(25) BOTTOM	120	High grade	80	13.5
		Low grade	40	13.1
Total	810	High grade (average)	520	12.28
		Low grade (average)	290	13.52
Control (18-19 days sun-drying)	220	High grade	220	10.5

Figure 18: moisture test, e-NAM lab

b. e-NAM quality parameters test applied to samples: control and B4(1)

quality Parameters	Weight %		comments to parameters
	control	B4(1)	
good	63.49	79.18	
pod_5	80.35	83.46	full length
pod_3_5	4.17	6.01	half length
Pod without stalk	21.75	7.04	better without stalk
Broken	5.05	4.74	
Discolor	0	0	
Foreign Matter	5.28	2.08	
Loose seed	0.26	0.96	

Pictures of the reports:

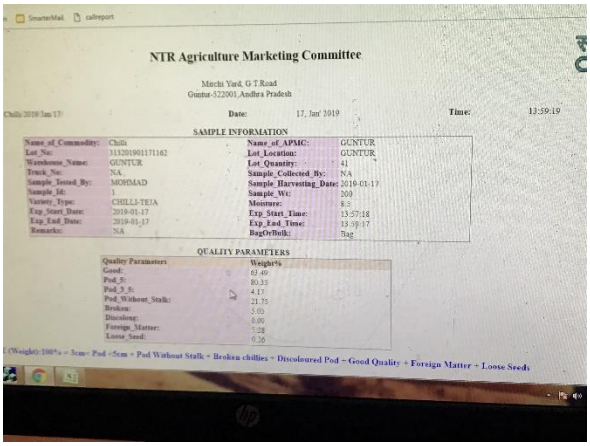


Figure 21: control sample report

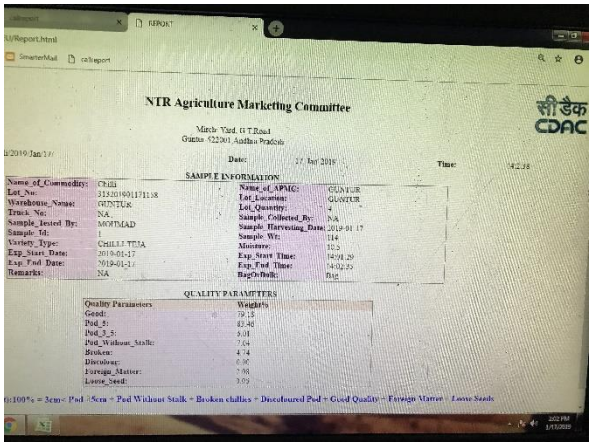


Figure 20: Dreyer sample B4(1) report

2. <u>e-NAM grading levels</u>

grade	Moisture %
First quality	0-9
Second quality	9-10
Third quality	10-11

- The visual quality is also important, for better looking chili in the same grade the price will be better.

3. The moisture content in our samples are too high:
    a. **Average moisture in high grade (after sorting): 12.28%**
    b. **Average moisture in low grade (after sorting): 13.52%**
    c. **Control sample moisture (high grade): 10.4%**
4. Price <u>estimation</u> after testing:
    a. Dryer produce (High grade): ~8000 INR (200-300 INR more than sun-dried produce)
    b. Dryer produce (Low grade): 6000 INR
    c. Sun-drying (high grade): ~8000 INR
5. E-NAM personal estimation: Though the moisture level of the sun-dried produce is lower, the dryer sample have better color and quality, therefore the drier sample will get better price.

Appendix D: AMAIZZ Fresh air dryer installation – inquiry

20 December, 2018

A. General information

1. Installation time: 2 days
2. Dates: 18-19 of December 2018
3. Location: Durgi chili market, Guntur district, AP, India
4. Installation plan: 1 fresh air dryer (capacity: 3 Tons) + 1 heated dryer (capacity: 1 Ton)
5. Installation field team (in compliance with AMAIZZ demands):
   Day 1 (17 people):
   a. Mr. Ido Batchko, COO & Co-Founder of AMAIZZ
   b. Mr. Veerabhadra Reddy VCF agronomist
   c. Licensed electrician
   d. Professional pipe cutter (contacted in field for structural changes in the dryer frame)
   e. 3 TAU students
   f. 10 hired workers from nearby villages
   Day 2 (10 people):
   a. Mr. Ido Batchko, COO & Co-Founder of AMAIZZ
   b. Mr. Veerabhadra Reddy VCF agronomist
   c. Licensed electrician
   d. 3 TAU students
   e. 4 hired workers from nearby villages
6. Inventory:
   Immediately after the installation on December 19th, TAU students recorded all the parts that have been used and unused and compared the inventory list with the orders received from AMAIZZ via email correspondence. In light of the many parts not being used, the team consulted with AMAIZZ personal on site to better understand which of the unused parts will be used for the heated model. A summary of the findings can be seen below, in table 1:

Table 1. AMAIZZ pilot (chili) installation - Inventory list

Part	Ordered	supplied	used	unused	comments
Steel pipes 2.2 m (frame)	38	38	34	4	Size did not fit the PVC sleeve, changes were made on-site with additional cost
Steel pipes 1.5 m (frame)	12	12	12	0	Inserted into the joint fully to accommodate the size of the PVC
3 way blind corner (joint)	16	16	16	0	
Wall flange (joint)	14	14	0	14	According to AMAIZZ: the part is not suitable and cannot be used (blocked at bottom)
Plastic plug 1-1/4' (joint)	15	15	0	15	According to AMAIZZ: the size is wrong and therefore cannot be used
Side outlet TEE 1-1/4'' (joint)	44	44	12	32	
Grub screw 5/5'' (joint)	10	10	0	10	Purpose of the part is unclear
Blue plastic palate	12	12	6	6	

(floor) 1200x1000x160 mm					
Green plastic palate (floor) 1200x1000x160 mm	12	12	0	12	
Plastic crates (for the produce) 600x400x80 mm	1000	1000	525	475	• Used for air dryer only • The expected capacity did not match the actual capacity of both dryers
PVC sleeve (cover)	2	2	1	1	The sleeve was too small for the steel pipes structure (1.5x2.24x4 m + 1.5x2.24x6 m)
Isolation foam panels (10x100x220 cm)	8	8	0	8	• for heated model only • Unclear if could fit into the PVC sleeve. • Additionally, according to the installer a designated slot for the fan was supposed to be made in one panel (we found no indication of this part being ordered in the correspondence) – there was no panel matching this description on-site
Isolation foam panels (10x150x150 cm)	3	3	0	3	
Isolation foam panels (10x150x80 cm)	2	2	0	2	
Heater (pump and small fan)	1	1	0	1	• For heated model only • Controller was found at the end of firs cycle (see closes C.4-7)
EM 50 fan new	2	2	1	1	• For fresh air dryer only • The Fan did not fit the size of the machine. It is unclear whether the capacity of one fan was sufficient.
Sensors	8	8	1	7	• The box containing the sensors was found by the students during the inventory check, and installed only after it was brought to the installer's attention. • It was unclear where the sensors are to be installed and how.
sensor modem	2	2	1	1	1 for each dryer
SIM cad for modem	2	2	1	1	1 for each dryer

B. Installation of the AMAIZZ fresh air dryer

1. Installation took 1.5 days.
2. There were no technical drawings available on-site, though a scheme of the structure was used by AMAIZZ installer via smartphone. As so many parts remain unused, it is unclear if the installation was according to original design.

3. The capacity of the machine is significantly smaller than estimated by AMAIZZ (1575 kg maximum of the Teja chili verity). While taking into consideration the fact the trays were smaller than initially ordered (due to shortage at the supplier), the size of the trays was agreed upon in advance with AMAIZZ and the measurements were known for many weeks. And though the exact type of chili was not agreed upon in advance (nor was this information requested by AMAIZZ), therefore making the exact amount difficult to determine, we would have expected to have a more accurate estimation based on simple simulation or even the most basic calculation. Unfortunately we could not receive any clarifications for this from AMAIZZ representative on-site.
4. The final product does not match previous design shared by the AMAIZZ team. The structure as well as the layout are different to the drawings shared by AMAIZZ (see figure 1).

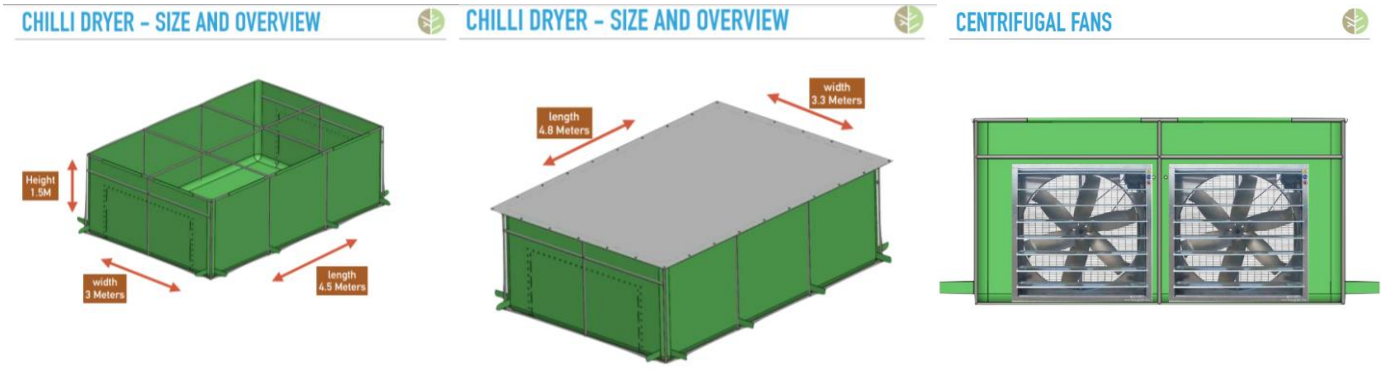


Figure 22: Dryer design as shared by AMAIZZ (images from AMAIZZ documents)

5. The size of the PVC sleeve did not match the steel frame, and on-site changes were made to enable the installation. Approximately 19 cm were cut off all long steel pipes (2.2 m). In order to do so, a professional had to be hired and brought onsite urgently at additional cost. This caused a delay in the installation, changed the structure design and added unplanned cost.
6. There were many excess parts, and though some might belong to the heated model, others are definitely extras belonging to the fresh air dryer, such as: the second fan, green platforms, joints that are unsuitable (see table 1).
7. Only 1 out of 8 sensors was installed, and the location and means of installation seemed unplanned.
8. The control box was fixed by zip-tie to the outer frame, which raised a security issue as well as a question of design.
9. AMAIZZ representative left as schedule, despite the fact that the app shared by AMAIZZ to control the fan was not fully functioning and data from the sensor did not stream constantly. Additionally, there was no time left for training the operators and the team on trouble shooting and common problems that may arise.
10. While installing the dryer it became clear that there were engineering trials required to determine the final layout of the machine. This was never brought forth by AMAIZZ previously, and was extremely surprising to the team as there were many discussions regarding the planed pilot, the design and constrains of the season for both chili and ground nuts. In light of this new information, a new pre-pilot was agreed upon, and an appropriate monitoring protocol was designed by TAU students. AMAIZZ did not share any monitoring protocol or gave any relevant and specific guidance as to the data collection, nor was it clear by which parameters the final layout was to be determined.

11. Unfortunately many operational issues were not addressed on-site, and many crucial points remained unanswered:
    a. In case of heavy rain the instruction is to close the opening of the dryer, yet it is unclear what is considered heavy rain, and what are the parameters to determine whether the dryer should be closed (for example: amount or duration of rain).
    b. There was no clear answer weather the dryer was to work continually during the night (contradicting answers were given), or if there are any parameters to determine on site whether it should be switched off or not (for example: temperature, humidity and wind).
    c. What kind of data will the sensor provide and what can be done to avoid condensation on the sensor which causes falls reading.
12. The finished dryer had tears in the PVC caused by the many changes made during the installation, it is unclear how and whether they should be fixed and if they will affect the drying process.

C. Installation of the AMAIZZ heated dryer

1. The heated model was more costly and had greater potential to be beneficial to the farmer as it was aimed to reduce drying time drastically.
2. There were no technical drawings available onsite, though later on TAU students found a similar design in the heat pump supplier:

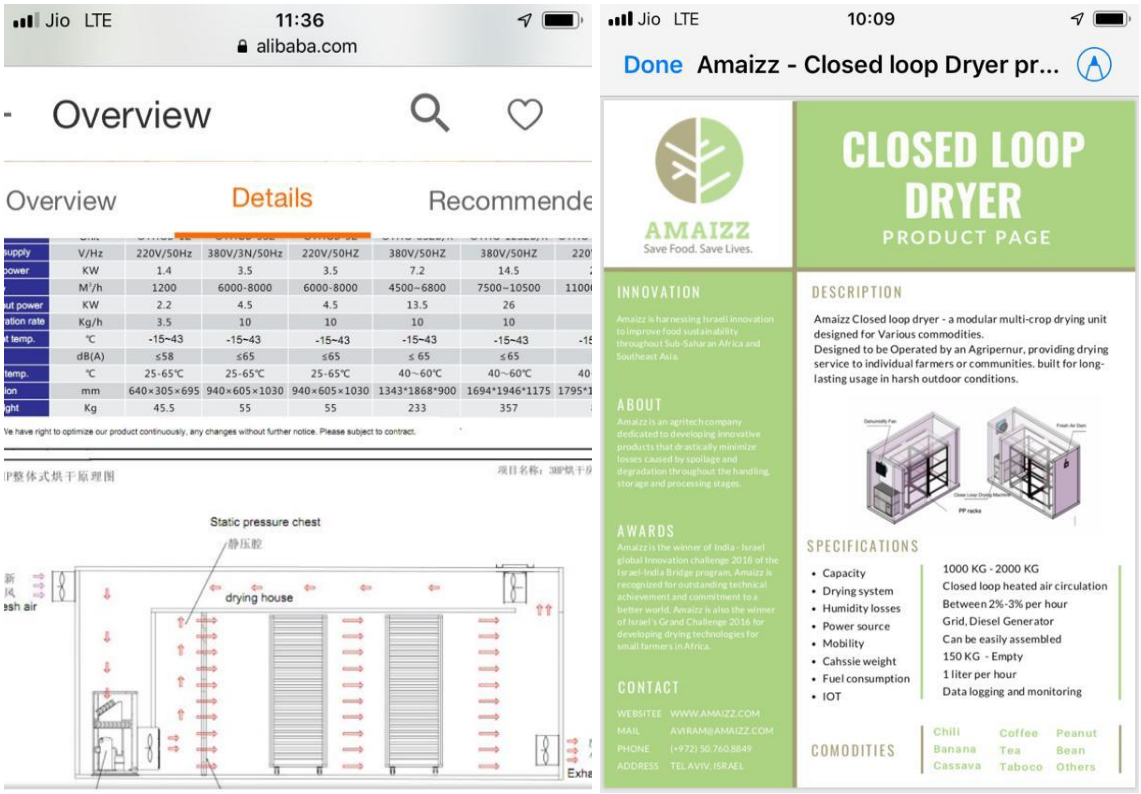


Figure 23: Left-detailed dryer design by heater supplier on Alibaba.com, right-AMAIZZ heated dryer scheme

3. Unfortunately the Installation of the heated dryer was not completed. Though the frame and cover sleeve were installed and left on site, the insulation and the heater were not installed, and it was never fully operational.

4. The main reason for the heated dryer installation not being completed was that the controller (a crucial part for operating the heater) for the heater was not found.

5. It was claimed by AMAIZZ team that the controller was supposed to be sent by the provider with the heater, packaged separately from the heater itself. They hypothesized that the controller was either not provided or lost/stolen while in India, marking the later as more likely as the original package had slight tears created during storage and relocation of the equipment to its final location in Durgi chili market (see figure 3). Furthermore, AMAIZZ claimed that the controller could not be inside the heater and strongly objected to opening the heater itself in search of the controller as it would render the provider's guarantee void, and release him from liability.

Figure 24: heater in Anantapur (note: tears in plastic cover on top)

6. It is important to emphasize that time constrains were such that it would not have been possible to assemble both dryers, even if all parts would have been accounted for.
7. The frame and cover of the heated dryer were installed, with changes made to the frame to match the size of the PVC sleeve, at additional cost (as mentioned in clause B.5). It is unclear whether the foam isolation panels would fit into the revised frame.
8. There was no time frame or operational plan set for the completion of the installation of the heated dryer.

D. Added on February 9th, 2019: finding the controller inside the machine

9. As the controller was crucial to the completion of the installation and the pilot being time sensitive, TAU team reached out to the provider, to inquire after the location of the controller. The provider stated that the controller was inside the heater and instructed the team to open the machine.

Figure 25 : opening the dryer and finding the controller by TAU students 8.2.19