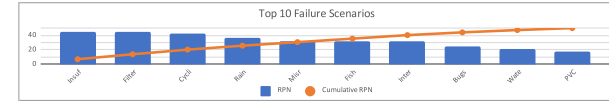


**Failure Modes & Effects Analysis**

System Name: Colombian Aquaponics Initiative  
 Major Function: Feed Family  
 Prepared By: TJ-MACK Aquaponics  
 Date: 10/26/2019

Ranking	Failure Scenario	Description of Consequences	Detection Event (If any)	Occurrence Severity	RPN	Cumulative RPN	Actions Recommended to Reduce RPN	FMEA Technique Exercised <sup>1</sup>	Primary Part Affected	
1	Insufficient cycling of water	Unable to maintain water parameters and fish die	Fish casualties	5	9	45	10%	Provide continuous cycling or accurate intervals to cycle water manually	Incomplete Function	Tank
2	Filter is too cumbersome for the farmer to replace	Injury to farmer or failure to cycle water resulting in fish casualties	Weight of filter is impaling the farmer, or interval of replacement is too often	5	9	45	19.1%	Utilize ergonomic best practices to ensure that weight of filter and intervals of replacement can be satisfied by vast majority of Colombian population	VOC	Filter
3	Cycling protocol is unclear	Water parameters not maintained	Fish casualties	6	7	42	28.1%	Ensure clear and accurate instructions for maintaining	VOC	Tank
4	Rain water contaminates water	Unable to maintain water parameters and fish die	Fish casualties	6	6	36	35.7%	Provide complete coverage of tank to protect fish	Environmental	Cover
5	Misreading of water parameters	Water conditions are not maintained and fish could suffer	Fish casualties	4	8	32	42.6%	Develop improved interface capabilities of the sensor	Interface	Sensor
6	Fish waste is not properly managed	Fish conditions are not optimal	Fish casualties	4	8	32	49.4%	Ensure waste is being cycled into the filter buckets	VOC	Tank
7	Intervals of maintenance are too frequent for farmer to maintain	System conditions could suffer	Plant and fish vitality are worsening	4	8	32	56.2%	Find optimal balance between farmer capability to lift and frequency to cycle	VOC	Filter
8	Bugs harm plants	Plant growth may suffer	Plant growth is reduced	5	5	25	61.5%	Utilize sustainable pest control measures to reduce pest impact	Environmental	PVC
9	Water flows out of fish tank when transferring into the filter	Water levels fall and could kill fish	Water level is below normal	3	7	21	66.0%	Ensure secure interface between the filter and tank	Failed Function	Valve
10	PVC piping drains water too fast	Duration of water cycling is shortened and interval to cycle increases	Timing of drainage time reveals that it is too frequent	3	6	18	69.8%	Ensure only a few small holes are drilled in the PVC to ensure steady drainage	Failed Function	PVC
11	Fish have insufficient space to grow	Some fish may not survive	Fish casualties	3	6	18	73.6%	Adhere to fish volume requirements	VOC	Tank
12	Sensor exposed to elements	Sensor could short circuit	Current location is exposing the sensor	3	6	18	77.4%	Ensure encasement of sensor as well as coverage from elements	Environmental	Sensor
13	Water is not evenly distributed to plants	Some plants may not survive	Some plants do not grow as much as others	3	5	15	80.6%	Test different configurations and slopes of plant bed to ensure even distribution	Incomplete Function	PVC
14	Sealing of PVC is inadequate	Plants will lose water quicker and could hurt vitality	Plant growth is reduced	3	5	15	83.8%	Ensure tight ealing of ends and close adherence to hole restrictions for drainage	Incomplete Function	PVC
15	Sunlight is inadequate for plants	Plant growth may suffer	Plant growth is reduced	3	5	15	87.0%	Ensure location with few obstacles preventing sunlight	Environmental	PVC
16	Filter waste goes unmanaged	Filtering ability is lowered due to excessive waste	Excessive build up of fish waste	3	5	15	90.2%	Determine intervals to clean out and replace filter	Interface	Filter
17	Evaporation rates are higher than anticipated	Lower water levels could hurt fish vitality	Fish casualties	2	7	14	93.2%	Ensure adequate research is carried out to determine evaporation rates and plain regular refills into the schedule	Environmental	Tank
18	Insufficient support of filters	Filter system may collapse	Deformities in the structure	2	6	12	95.7%	Perform detailed physics and CAD analyses to ensure optimal support design	Failed Function	Support
19	Crops have insufficient space to grow	Plant growth may suffer	Limited plant growth	2	5	10	97.9%	Ensure optimal distance between plants is adhered to	VOC	PVC
20	Sensor materials cannot be procured or are too expensive	Water parameters must be tracked manually	Local materials not available or out of budget range	5	2	10	100.0%	Ensure complete and accurate instructions for manual testing of water parameters	VOC	Sensor

	RPN	Cumulative RPN
Total Failures	20	n/a



	RPN	Cumulative RPN
VOC-Based	7	35%
Failed Function	3	15%
Incomplete Function	3	15%
Environmental	5	25%
Interface Failure	2	10%

Total RPN 470

Part	Frequency	Cumulative Frequency
Tank	5	25%
Support	1	30%
Filter	3	45%
Sensor	3	60%
PVC Plant Bed	6	90%
Valve	1	95%
Cover	1	100%