

Fab Lab for Solving real life Problems: Solar Egg Incubator: Journey from identifying need to providing solution

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Abstract

The project to develop an egg incubator is undertaken at Vigyan Ashram Fab Lab. The lab used traditional fabrication tools and tools for digital fabrication to make this egg incubator. This is designed and developed mainly by rural youth dropped out of school. It demonstrates how, if proper tools and environment are provided, it empowers individuals to solve their own problems. Modern poultry industry is run by big corporates with big hatcheries of huge capacities. It results in exploitation through monopoly of trade. Incubators available in the market are far greater in size than requirements of small villages. It also requires generator backup and therefore requires major investment. An idea of an egg incubator with 100 – 1000 eggs capacity emerged from this need. This is foreseen as a good business opportunity for women Self Help Groups and village youth. Temperature in the incubator is maintained using solar water heater, LPG or electricity. Tubes carrying hot water from solar heater are circulated inside the chamber to maintain the temperature. Tray rotation, maintenance of humidity etc is automatic and powered by solar energy. Electronic parts and casings of the electronic circuits were primarily done using tools in the Fab Lab. The project started with actually recording all temperature and humidity readings from the real hen sitting on eggs. Five versions of Egg incubator were made. We got 85% results consistently in experimental trials. We started selling the unit and sold one unit of 500 eggs & one with 1000 eggs capacity. We have also designed a business model proposal for farmers. Now we are in process of standardization of parts and reducing the cost.

Keywords

Egg incubator, solar powered egg incubator, Fab Lab project, Vigyan Ashram, rural technology

Fab Lab for Solving real life Problems

Solar Egg Incubator : Journey from identifying need to providing solution

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Abstract-

The project to developed egg incubator is undertaken at Vigyan ashram fab lab. The lab used traditional fabrication tools and tools for digital fabrication to make this egg incubator. This is designed and developed mainly by rural youth dropped out of the school. It demonstrates, how if proper tools and environment is provided. It empowers individual to solve their own problems. Modern poultry industry is run by big corporate with big hatcheries of huge capacities. It results in exploitation through monopoly of trade. Incubators available in the market are far greater in size than requirement of small villages. It also requires generator backup and therefore requires major investment. An idea of an egg incubator with 100 – 1000 eggs capacity is emerged from this need. This is foreseen as a good business opportunity for women Self Help Groups and village youth.

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Introduction

Vigyan Ashram (www.vigyanashram.com) is located in small Indian village Pabal. It is training rural youth in raising poultry from last 30 years. Pabal being a drought hit area; the nearby areas have limited scope for agriculture. Over the time, the area has become hub for chicken supply for Mumbai in particular and Maharashtra in general.

Pabal is surrounded by almost 70-80 poultry farms with bimonthly capacity of 150,000 birds. Most of the poultry farms undertake contract farming where in the poultry company gives them chicks @20-22 INR (\$0.3) per bird, food as per the company specifications and medicines in exchange of full grown birds at the end of 45 days. The poultry farmer makes @10 INR (\$0.16) on an average per bird in exchange of doing labor work in raising chickens and providing real estate space for the chicken (almost 1-1.2 Sqft area per bird). In summary, the company is offloading its fixed cost and labor to the poultry farmers. This system is beneficial for both because, farmer is isolated from business risk whereas poultry companies can get benefit of decentralised production and less manufacturing and labour charges. However

these are some of the grievances expressed by farmers -

i. The farm is always under capacity (70-90%) as the supply of chicks is controlled by poultry companies.

ii. They raise the chick prices unilaterally without consulting the farmers affecting their bottom line.

iii. In India, some months are religious and many people do not eat chicks during those periods. Market prices are low during those periods. Market is controlled by hatcheries or their own advantage and those who are not under contract farming but need chicks from hatcheries always suffer.

i. Companies breed broiler birds. There are many local chick breeds which are preferred by locals and get good rate. They are mainly grown in backyard poultry and by traditional hatching practices. Their production cannot be scaled up since small hatcheries are not available.

Need of small incubator

There are many youth and women self help groups, who want to start poultry as business. But they don't have scalable real estate space for making large poultry farms to enter into under contract farming. For contract farming, one needs 9000 sqft area to raise around 9000-10000 birds at a time. They lack money and depend on bank loans for starting the business. Further Poultry companies offer their contract in selected geographical areas. It is difficult for them to supply chicks in remote areas. The solution to this problem is to start small hatchery unit to meet local requirement and become independent from big hatcheries.

Product available in the market and limitation:

There are incubators of several sizes available in the market. Most of them are of the sizes of min 1000 eggs and above. They need electricity to run the hatchery unit.

Electricity supply in Pabal village (and most of the remote Indian villages) is not reliable. Therefore purchase of diesel generator is a must with electrically operated hatcheries. This

adds to capital investment and operating cost.

During the formulation of project for Vigyan ashram students, it was decided to work on the problem and develop an incubator with following features :

i) A egg incubator which will run on solar , fire wood / kerosene / LPG etc.

ii) It will be of 100, 500, 1000 eggs capacity to meet local requirement of chicks.

iii) It should be economical and make a business sense.

Fab Lab and Designing of egg incubator :

Vigyan Ashram (VA) trains its students using 'Learning while doing' methodologies. It tries to inculcate values of scientific temper, experimentation and seeing every problem as an opportunity. VA has got a Fab Lab established in 2002. VA philosophy of 'Learning while doing' and Fab Lab motto of 'You can make almost everything !' set the new aspirational tone in VA community. Modern machines in the fab lab for digital fabrication along with traditional fabrication and hand tools started giving birth to new ideas.

Egg incubator project is taken in that line. VA students need to complete 4 projects in a year as a part of course work. Egg incubator got involvement of students over last 3 years. List of the sub projects done as part of main projects are :-

i) Actually measuring temperature of hatching egg using natural method of hen sitting on chicks

ii) Making a prototype of 20 egg incubator on electricity and comparing it with natural hatching.

iii) Making prototype of 20 egg incubator on solar.

iv) Making egg tray on laser cutter machine and tray rotational



mechanism.

Fig.1 : Egg

Tray

- v) Designing systems for temperature and humidity control.
- vi) Alarm in case temperature/humidity drops down the permissible level. Or rotational mechanism fails.
- vii) Designing a 100 egg incubator and manufacturing & testing it.
- viii) Standardising 100 eggs incubator and launching it.
- ix) Manufacturing of 1000 eggs incubator.
- x) Business plan for small hatcheries.

Automation and controller part is mostly done in the fab lab. Laser cutter and vinyl was used wherever possible, especially for enclosure for electronic parts, name plates & egg trays etc. PCB were made by traditional method. Vigyan Ashram alumni and now instructor Mr. Anil Gade lead the project from beginning till its completion for past 3 years.

Critical Factors in Designing hatcheries :

Following are the critical factors which were considered during designing hatchery.

- i) Temperature 37.5°C
- ii) Humidity 85 – 87 wet bulb
- iii) Rotation of the egg – Once in a hour
- iv) Ventilation – Maintaining air circulation

Initially, option of providing solar electric backup using inverter was explored. Commercial 1000 egg incubator

requires @ 450W of power. Cost of solar panel and batteries makes it unviable. Further it could not replace the diesel generator during rainy & cloudy days. Hence it is decided to maintain temperature in the incubator chamber by circulating hot water. The water can either be heated by solar water heater or any other heating source like firewood/LPG/Keroscene stove. General arrangement is shown as below –

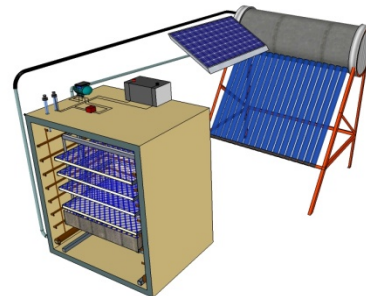


Fig.2 : Sketch of the system

Fabricating the stuff :

- i) Incubator box :-- In the first few prototype, a box made of tin sheet was fabricated. For solar trials old refrigerenator box was used as incubator chamber. After successful experimentation, FRP (Fiberglass Reinforced plastic) box is made for commerical version.



Fig. 3 & 4 : Incubator chamber in tin sheet



Fig. 5 : Incubator chamber in old fridge , Fig.6 FRP box for commercial order.

ii) **Maintaining Temperature :-** Copper tube is circulated inside the chamber. Temperature of water from solar water heater is between 65° C-70° C. Flow of liquid is controlled to maintain 37.5°C temperature inside the chamber. Copper tubes are conveniently fitted into the chamber. To distribute the heat evenly in the chamber, copper roll (Fab inventory) is used (Fig.5)



Fig.7 : Inside

the box

iii) **Maintaining humidity :**

Each component in the incubator provided opportunity for students at different levels to explore new ideas. Conventional incubator uses wet cotton cloth and a fan. Students designed a different fan to maintain humidity from available material (toilet brush) to avoid dribbling of water & clogging of fan due to hardness of water.

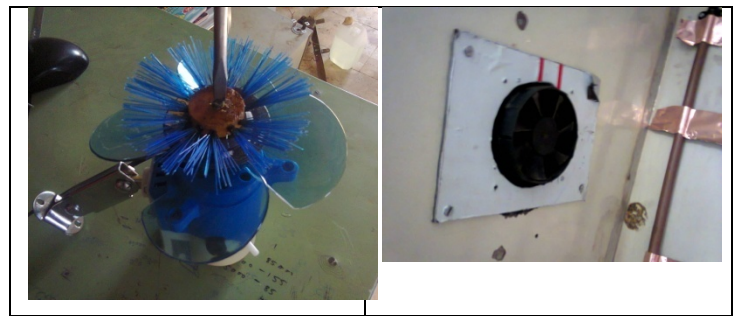


Fig. 8 Design for maintaining humidity

iv) **Rotation of Tray :** It is realized that conventional hatcheries have a fixed tray and it is difficult to clean them from inside. Therefore tray assembly is designed as an independent unit. Further hatcheries in the market uses stepper DC motor for tray rotation. It costs around INR 15000/-. It was replaced with motor used in automobiles to operate glass windows. Later on it is replaced with wiper motor in the automobile. Wiper motor with timing motor and limit switches. This together reduced the cost of mechanism by 75%.



Fig.9 : Rotating tray unit

v) **Finishing and aesthetics :** After initial trials and generating enough confidence in the idea. Attention is given on finishing of the product.



Fig.10 : Name plate cut on laser cutter

vi) **Testing incubator** : Present egg incubator is in its fifth version. It went through many trials. In order to test the system and to record temperature, humidity and rotation of trays, students kept round the clock monitoring of the system. In the initial trails, there were some failures. Especially rotation of tray and failure of temperature control system. Results of the trials are given below :-

	Incubator Trial	Trial completion date	% success of trial	Comment
1	100 Eggs	10th Feb 2010	12%	Humidity fan Damaged, Rotation manual
2	100 Eggs	31 st March 2010.	91%	Rotation manual
3	20 Eggs Solar	12th Oct 2010	4%	Problem in water controlled system
4	20 Eggs Solar	7th Oct 2010	85%	
5	500 eggs trial on solar	18th Nov 2011	40%	Problem in water circulation
6	500 egg trial on solar	18th Oct 2012	0%	rotation system failed
7	500 egg 3rd trial solar	9th July 2013	69%	water controlling system failed
8	100 egg incubator	10th Mar 2013	86%	Machine sold
9	1000 egg incubator	7th Aug 2013	85%	Machine sold

Developing business model :

A project to develop an order execution system and business plan for prospective customer was given to students of 'S.P Jain Management Institute'. These MBA students helped to develop a business plan and templates for investment and return on investment to potential

customers. They develop a tool in Excel for calculating return on investment.

Anil, who was involved in development from the beginning of the project has decided to take the idea as his venture. He invested the money in design and look of the incubator. He formed a enterprise 'M/S Future Innovative Systems' and started production of incubator.

He got first order for 100 eggs incubator for Rs.40,000 (\$ 660) and second order for 1000 eggs incubator for INR 85,600 (\$ 1600).

It is found that pay back period for 1000 eggs incubator with electricity is 10 months and with solar, it is 15 month.

Advantages of an egg incubator as follows :

- 1) It consumes less power than other Egg incubators available in the market.
- 2) It's fully automated machine and minimum external supervision or control required.
- 3) Easy to operate :- Any person can handle or operate it easily and no special skills required. It is 10 - 30% cheaper than equivalent market product. It also provides added advatages.

CONCLUSIONS :

The project on developing egg incubator is undertaken by students who were not very good academic performer and many of them not studied beyond 10th class. They were trained by 'learning while doing' methodology & ask to work on real life problem. They were given all tools and opportunity to work by hand. They could see relevance of problem and came up with many small innovation, many are very local specific solutions. This is an example of how creative energy of even rural, less educated youth results in a useful contribution to the society. Role of Fab Lab is very important to create a confidence & attitude of 'You can make almost Anything !'

There is still a scope for optimization of solar & heat transfer system in present egg incubator. Standardisation of automatic system is also needed. The project definitely helped in identifying need and explored direction for viable solution.

ii) <http://vigyanashram.wordpress.com/category/solar-powered-egg-incubator/>
iii) <http://vigyanashram.wordpress.com/2010/11/11/solar-egg-incubators-success-trial-85-success-result/>

I. Acknowledgements

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Specification of incubator:

Size: 1000 eggs

Inlet temp of hot water: 65 to 70°C

Temp inside the chamber: 37.5 to 37.7°C

Humidity: 85 to 87%

Tray rotation frequency: 1 hours 45 dirge

Blower fan: 24 Watts

Dimensions: 160cm * 101cm * 196 cm

Recommended solar water heater: 250 Liters

Selling price : INR 96000 (\$ 1600)

part of the research at Vigyan Ashram. Special thanks to Center for Bits and Atoms at Massachusetts Institute of Technology (MIT) for establishing Fab Lab at Pabal, which makes many of the things possible.

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- [4] Results on the blog :
i) <http://vigyanashram.wordpress.com/2013/03/06/egg-incubator-trial/>