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RESEARCH ARTICLE

AN INNOVATIVE APPROACH TO RECONCILE FORESTRY WITH ECONOMY BY MEANS OF NEO VERTICAL AGRO-FORESTRY

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ABSTRACT

Agronomic productivity is not matching up with the needs of the 21st Century. United Nations asserts India is expected to become the largest country in population size by 2022. Urbanization has been a potential threat to the tree cover and forests. Out of the many problems our paper intends to solve, this is just one. The primary purpose behind the study is to come up with a model that does not sacrifice forestry for economy or vice versa. It is based upon the conception of vertical farming, which refers to the cultivation of crops (or any other vegetation preferred; we chose to primarily grow medium size trees) on vertically stacked levels. In this paper, we present a four storied architectural structure that serves both agroforestry and corporate purposes. A critical assessment of the model is conducted in order to test its economic feasibility. The yields produced by the proposed model is not bounded by limited land, and is hence multiple folds. Every floor has a particular sort of vegetation chosen with tremendous care. The floors simultaneously provide services such as a library, a health improvement centre, an animal husbandry area, a playground and a forest. The building is powered by energy sources such as gravity light, biogas, and solar trees. And, the best part about it is that it can be in your neighbourhood.

INTRODUCTION

Substantial urban expansion has become a cause of adverse environmental problems worldwide, including deforestation, climate change, conversion of arable land into non arable land etc. In fact, a statistical analysis (Ministry of Statistics and Programme Implementation, GOI, 2015) conducted by the Government of India clearly states, "By the end of the 21st century, it is very likely that sea level will rise in more than about 95% of the ocean area. About 70% of the coastlines worldwide are projected to experience a sea-level change within ± 20% of the global mean." Urbanisation has also caused a segregation between the nature and modern settlements. Breathing "clean air" has become a potential subject of bragging. We, however, speculate the possibility of a forest in your neighbourhood. In this paper we present an architectural structure that establishes a harmony between nature and essential urban services. A four-storied forest thatserves as an animal husbandry area, a health improvement centre, a library, a playground, and a forest- all at the same time. That is only a mere description of what our paper offers. Nature is self-sustainable, and so is our model. Nothing that enters this forest is a waste.

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Every beam of sunlight that illuminates the farm is distributed evenly across the vegetation with the help of parabolic lenses. Beside the solar trees that provide the farm electricity for any urban activity, the farm also uses gravity lights and bio gas (produced from the waste of the cows reared in the special animal husbandry area built on the ground floor). In table, 1 we discuss the problems that the modern agroforestry sector is facing, and how our model aims to solve it.

Building Structure

The model is a four-story building (Fig.1) – in which every floor is a tree cover; the floors.

Azolla – Azolla (Azolla Pinnata) is a plant, introduced and popularized in 1990s, which also acts as a fertilizer that provides the soil with many nutrients, along with the primary nutrient N, P and K (5%, 1% , 5% respectively). Because of its essential nature (i.e. purely organic), it is very productive in the long run (Go to ref. 3 to know more) also provide various other urban services. Accessibility to the building and the services provided requires a certain fee to be paid (For further information, refer to Section 4.2). Further, we will discourse the utility of each floor along with a brief description of the vegetation grown.

Table 1. Model's Objectives

Sl. No.	Problem	Solution	Proof
1	Irrigation -Only 36% of India's total land is reliably irrigated (World Bank, 2013)	• O.M.C • Rainwater harvesting • Zero Wastage	• O.M.C is the optimum moisture content required by a plant. We will study each plant's OMC and irrigate accordingly. • Just by rainwater harvesting, with an annual rainfall of 800mm rainfall on a terrace of 1000sq. m, we will accumulate 800000L. • The water will be properly stored, resulting in minimal to no evaporation of stored water.
2	Unfertile Soil -Environment statistics suggest that 39% of soil is degraded in Punjab. Similar fate is shared by a lot of other geographical area in India.	• Bio-Fertilizers and Compost • Preventing degradation of soil.	• Bio-fertilizers and compost will replenish the soil's nutrients without inflicting any harm. • We will not use any sort of artificial tool which will in turn degrade the soil. • We plan to use "**azolla**" which can be used as a fertilizer with excellent properties.
3	Limited land	• Multiple floors	• With our multi storied farm, the produce will be as many times as the number of floors on the same piece of land.
4	Energy	• Gravity light • Solar Trees • Bio gas	• Gravity light will convert gravitational energy into mechanical energy, and then into chemical energy. • Solar trees are solar panels attached to a pole which will increase space efficiency. • The excreta of the animals reared would be used to produce bio gas.
5	Soil Erosion -It has been estimated, a total of more than 5000 tonnes of top soil is being eroded every year (Milkha S. Aulakh, *et al.*)	• Confined apparatus	• Since the farm would be a building, with our mosses acting as side walls, soil erosion by wind would not occur. Because of no extra water, water cannot cause erosion as well. In simpler words, we would not allow any agent of erosion to be a part of the apparatus.
6	Environmental Issues	• Afforestation and eutrophication • Organic Farming	• Forests are cut for agricultural purposes due to scarcity of arable land. Farms like ours would lessen the need of cutting forests and the environmental benefits of forests would not be lost. • Runoff of water containing nitrogen fertilizers which have the chemical property of absorbing oxygen from water can be prevented with our confined apparatus.

Ground Floor

The ground floor of our model will serve as an animal husbandry area, where cows would be reared.

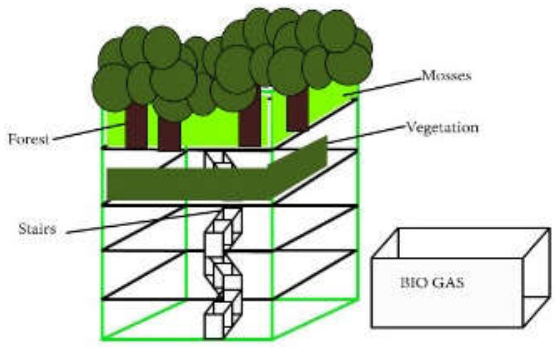

Figure 1. Model prototype

They would be reared by specialized employees. Their milk would be merchandized. The waste would be sent to bio gas plant for energy production.

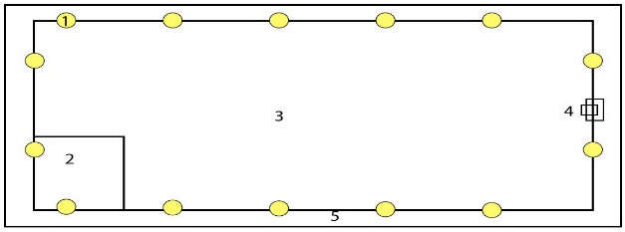

Figure 2. Ground Floor

1st Floor

The first floor will serve as a health improvement centre. Research asserts that increased level of oxygen in the environment leads to faster recovery from illness. An environment which makes the proposition formerly mentioned possible can beachieved with the help of mosses (which are known for their relatively higher rate of converting deoxygenated air into oxygenated air and will act as sidewalls in our model) and neem trees. People traumatized can also come here for a natural therapy session. The trees would adapt themselves in order to not be oversized for the space. The natural adaption would be extensively supplemented with controlled growth

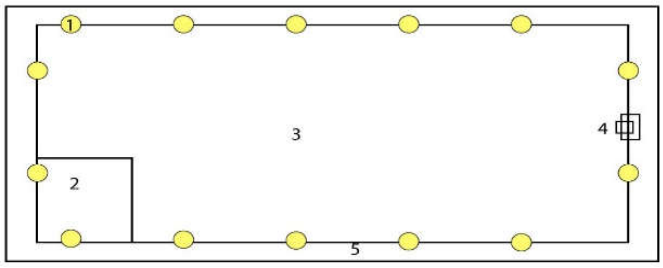

Figure 3. First Floor

Model Description

In table 2, we state the fundamental features of the model. According to the requirements of the farm, the apt number of floors is 4 (excluding the ground floor) with total area of 40000 sq. ft.

2nd Floor

The second floor primarily serves as a library. Apart from a substantial increase in concentration level, the setting offers a rare experience: a library amidst a bamboo forest.

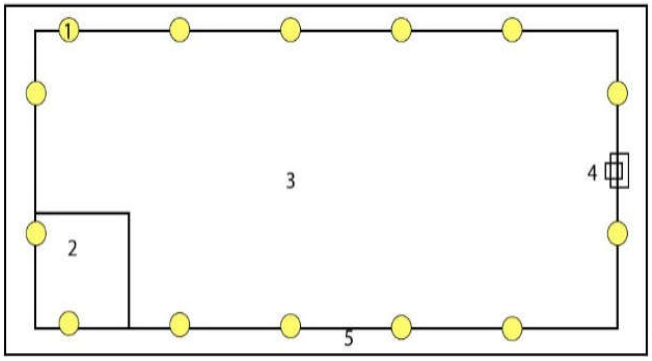

Figure 4. Second Floor

3rd Floor

The third floor serves as a playground. The vegetation on this floor – Senna – is carefully chosen to meet the setting. The plant possesses commercial significance as well as an appealing structure.

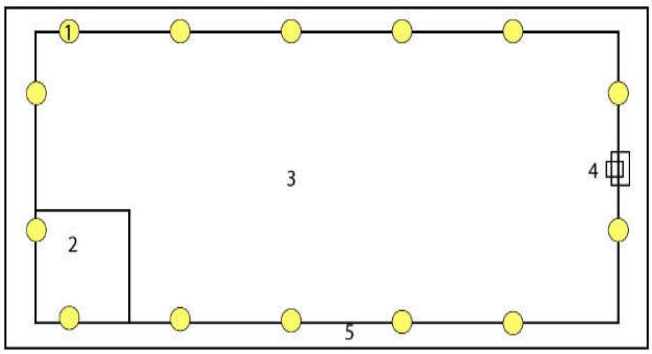

Figure 5. Third Floor

4th Floor

The top floor would be the marrow of the model. It is a full fledging forest. Babool and Guava would be the primary vegetation on the floor. The floor also features solar trees which provide the model a major part of the energy it requires.

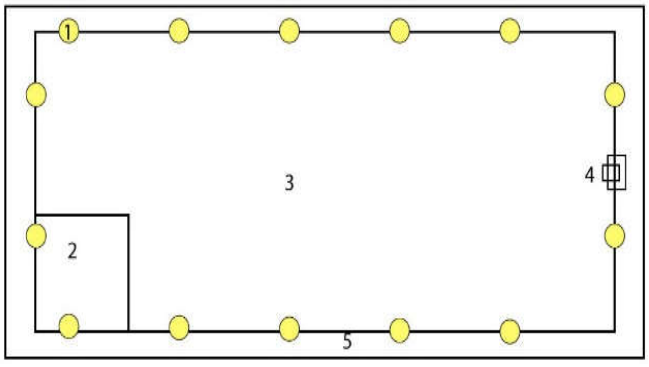

Figure 6. Fourth Floor

Common Index-
1- Gravity Light
2- Water Tank
3- Vegetation/Service Area
4- Staircases
5- Pathway

Model Description

In table 2, we state the fundamental features of the model. According to the requirements of the farm, the apt number of floors is 4 (excluding the ground floor) with total area of 40000 sq. ft. Each floor has a vegetative area of 700 sq. ft. Rest of the area is reserved for pathway, benches, and water tank. The 3rd floor- the only exception - has a vegetative area of 500 sq. ft. The rest of the area is reserved for a playground.

Resources

Since the majority of the resources that the model demands is produced within the model itself, the net monetary investment is extensively minimized. The primary water requirement of the model is to be met with the rainwater harvested. Only by rainwater harvesting, with an annual rainfall of 800mm rainfall on a terrace of 1000sq. m, 800000L of water will be accumulated. The rest of the water requirement will be fulfilled by water pumped out of the ground.

Table 2. Model Description

Building Description	
No. of floors	4
Area of each floor	10000 sq. ft.
Height between two consecutive floors	15 ft.
Height of the entire building	75ft.
Total Growth Area	26000 sq. ft.
Vegetation	Growth Area
Neem	7000 sq. ft.
Bamboo	7000 sq. ft.
Senna	5000 sq. ft.
Babool*	3500 sq. ft.
Guava**	3500 sq. ft.
Assets	Quantity
Cows	30
Gravity Light***	100
Bio Gas Plant	1
Solar Trees (5 panels attached to 1 pole)	20
Personnel	10

2 distinct 5KW solar panel systems installed in the model would create 9MW units per annum. On the other hand, an average cow producing 20kg of dung on a daily basis, which would be equal to $1m^3$ of bio gas per day, would be producing 2 KW a day. Our model features 30 cows. In one annum, therefore, the net electricity produced from bio gas would be 22MW.

Table 3. Revenue Generation

Annual Membership Fee	Rs. 24000
No. of membership issued annually	500
Annual Monetary Gain from Services provided	Rs. 12000000

Figure 7. Bio Gas (left); Solar Tree (Right)

Feasibility Assessment

In the table, mentioned above, an annual gain of Rs. 12000000 is made. There are primarily two underlying assumptions behind the claim. Firstly, on each floor (excluding ground floor), members occupy an area of 10 sq. ft.; secondly, the functioning duration of all the services is 12 hours a day during which every member has the liberty to spend 1 hour per day on any floor of choice. Depending on the contemporary economic situation, the annual fee collected can vary ±15%. The model is unarguably feasible in context of the profits it can reap. Calculated speculations suggest that the initial investments would be amortized in 8-10 years. Thereafter, the annual profit would be 150-200% more than the annual investment made.

Recommendation

The study can be further pursued with the incorporation of the following suggestions – a similar study with a water condenser in order to store and utilize the water lost due to transpiration can be conducted at a larger scale, a similar study can incorporate a fish tank within its thesis, and a similar study with the definite purpose of the examination of social and political acceptance of the model can be conducted.

Conclusion

In this paper, we have discoursed the need of reconciliation of mankind with nature. The study offers a model that aims to do what we formerly mentioned. The study has clearly showed that a successful model can be established that harnesses the natural potential of such reconciliation. We have, hence, proved that a good economy ought not to be sacrificed for nature or vice versa.

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