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Case Study

Nurture the Nature by Rooftop Gardening

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Abstract

Either rural or urban the rooftop can be a good place for gardening. Minimum three decimal spaces are not bad at all. With this activity the gardener can get enjoy for nourishing those plants. For avoiding insecticides in crop field these rooftop fruits and vegetables are good for human health. For rooftop gardening, some wildlife especially birds may come. So for ecological aspects this gardening system is good. Some common appliances like knife, waterer, spade, chemical and organic (natural) fertilizer, sand, pheromone trap, and very few insecticides are needed. Different size and shape of the tub is important depending on the type of plants. Bonsai plants need flat tub. For large sized (grafting tree) tree needs large sized tin tub. Hybrid fruit plants are suitable for giving crops early. Vermicompost manure is becoming popular in Bangladesh not only in field but also for rooftop gardening. On the roof of 71 N. S. Road, Kushtia, Bangladesh observed total plants were 83 but the identified species were 81. Out of 83 plants flowering plants were the highest (25) and the lowest medicinal, forest, and cactus. On the other hand, out of 38 families of those plants Euphorbiaceae was the highest (9), then Lamiaceae and Asparagaceae (6), and Cucurbitaceae, Apocynaceae, and Cactaceae (4) each. The prices of those rooftop plants are reasonable in Bangladeshi nursery. Bangladesh government has taken lots of initiatives for rooftop gardening. Concern authorities are trying to motivate people for engaging with this rooftop plantation.

Findings

Collected Plants

For a small family on three decimal roof places is enough on the basis of their daily demands. Fruits especially hybrid varieties are good on roof. For the evening snacks these fruits are sufficient. On roof most of the plants are ornamental. Exotic plants and bonsai all are genetically small in size. Some medicinal plants but ornamental especially Aloe vera was common on roof of the house. Then Oscimum sanctum for its extract for fever was adequate. Cactuses are lived by very small amount of water and its longevity is higher. It looks nice and can be transformed in bedroom/drawing/dining room. Bhadalia of Kushtia town they have lots of nurseries with the residences. In Bittipara of Kushtia, a vermicompost plant is fulfilling the demand of organic manure for the crop fields as well as rooftop plants. Sometimes the farmers are involved for grafting of their rare and good plants.

Appliances

At 10:00 am and afternoon 5:00 pm was the time for nurturing those plants. Before planting any seed the farmer used antifungal solution for purifying those seeds and soil should purified by warm water. In order to planting the base of the tub first fills up with 1 inch height sand and this is must for cactus type plants. Under this a piece of curved solid mud will use on the pore of the tub. At first good soil is sieved then put sometimes in the sun. Then this soil is stored in a sac for one month. After this time then 50% soil and 50% vermicompost are mixed well and put in those tubs. Then it is suitable for tree planting.

Pheromone Trap

On a three decimal roof only three pheromone traps are sufficient. Some insects especially beetle and flies were common but not harmful. If management and care is sufficient all plants will grow and give crops well. Only in lemon plant more pests were common. Chemicals and manure in evening is enough for protecting them. Chemical fertilizers can be used very little but we should remember that this is poison. Try to avoid these chemicals. Vermicompost was the best for any plants moreover the price of this vermicompost was only 10 taka per kilogram. It has no bad odor too. This is dry and easily stored for a long time.

Table 1: *Measurement of different tubs*

Mouth (inch)	Height (inch)	Shape	Made by
27	15	Round	Tin
23.5	17.7	Round	Cement
22.5	13.3	Round	Cement
22	14	Round	Cement
18.5	12	Round	Cement
18.5	11.5	Round	Cement
14	9.5	Round	Cement

12	15	Round	Cement
11	6	Round	Cement
9.5	7.5	Round	Cement
21×14	11	Rectangle	Plastic
15	5	Square (for Bonsai)	Cement
13	9	Square	Cement

Table 2: *Hanging bed for the creepers*

Length (inch)	Width (inch)	Plant
114	50	Grape
87	47	Bean
82	60	Ash Gourd
55	40	Long Bean

Table 3: *Observed rooftop plants of 71 N. S. Road, Kushtia- 7000*

Group (no.)	Family	Bangla Name	English Name	Scientific Name
Fruit (15)	Rutaceae	Kotbel	Wood Apple	*Limonia acidissima*
	Rutaceae	Komla	Orange	*Citrus aurantium*
	Rutaceae	Lebu	Lemon	*Citrus limon*
	Vitaceae	Angur	Common Grape Vine	*Vitis vinifera*
	Musaceae	Shagorkola	Cavendish Banana	*Musa acuminata*
	Lythraceae	Dalim	Pomegranate	*Punica granatum*
	Oxalidaceae	Kamranga	Star Fruit	*Averrhoa carambola*
	Rhamnaceae	Boroi	Red Date/Chinese Date	*Ziziphus jujube*
	Apocynaceae	Koromcha	Bengal Currant	*Carissa carandas*
	Oleaceae	Jolpai	Olive	*Olea europaea*
	Myrtaceae	Jamrul	Malabar Plum	*Syzygium cumini*
	Myrtaceae	Peyara	Guava	*Psidium guajava*
	Anacardiaceae	Amra	Hog Plum	*Spondias mombin*
	Anacardiaceae	Aam	Mango	*Mangifera indica*
	Sapotaceae	Sopheda	Sapota	*Manilkara zapota*

Vegetable (11)	Cucurbitaceae	Mistikumra	Sweet Gourd	*Cucurbita pepo*
	Cucurbitaceae	Jhinga	Ridge Gourd	*Luffa acutangula*
	Cucurbitaceae	Korola	Bitter Gourd	*Mimordica charantia*
	Cucurbitaceae	Chalkumra	Ash Gourd	*Benincasa hispida*
	Malvaceae	Dharosh	Okra	*Abelmoschus esculentus*
	Solanaceae	Morich	Green Pepper	*Capsicum frutescens*
	Solanaceae	Begun	Brinjal	*Solanum melongena*
	Cariaceae	Pepe	Papaw	*Carica papaya*
	Fabaceae	Borboti	Long Bean	*Vigna unguiculata*
	Fabaceae	Chim	Lablab Bean	*Dolichos lablab*
	Lamiaceae	Pui	Basil	*Ocimum basilicum*
Medicinal (4)	Lamiaceae	Tulsi	Holy Basil	*Ocimum sanctum*
	Asphodelaceae	Ghritoku-mari	Aloe	*Aloe vera*
	Asphodelaceae	Ghritoku-mari	Zebra Aloe	*Aloe maculata*
	Crassulaceae	Pathorkuchi	Life Plant	*Bryophyllum pinnatum*
Flower (25)	Rosaceae	Golap	Rose	*Rosa centifolia*
	Lamiaceae	Bugleweed	Bugleweed	*Ajuga reptans*
	Amaryllidaceae	Deshi Lily	Snowdrop	*Galanthus nivalis*
	Amaryllidaceae	Blood Lily	Blood Lily	*Scadoxus multiflorus*
	Amaryllidaceae	Rain Lily	Rain Lily	*Zephyranthes rosea*
	Euphorbiaceae	Fireball	Poinsettia	*Euphorbia pulcherrima*
	Euphorbiaceae	Cactus	Bush Crown-of-Thorns	*Euphorbia milii*
	Euphorbiaceae	Cactus	Crown-of-Thorns	*Euphorbia milii* var. *splendens*
	Euphorbiaceae	Cactus	Zig Zag Cactus	*Euphorbia pseudocactus*
	Euphorbiaceae	Cactus	White Crown-of-Thorns	*Euphorbia lophogona*
	Balsaminaceae	Orange Jewelweed	Orange Jewelweed	*Impatiens capensis*
	Rubiaceae	Rongon	Jungle Flame	*Ixora coccinea*
	Onagraceae	Shandhama-loti	Evening Primrose/Four o'clock	*Oenothera lamarckiana*
	Asteraceae	Chandramal-lika	Chrysanths	*Chrysanthemum indicum*
	Sapotaceae	Bokul	Spanish Cherry	*Mimusops elengi*

	Apocynaceae	Togor	Crape Jasmine	*Tabernaemontana divaricata*
	Apocynaceae	Noyontara	Madagascar Periwinkle	*Catharanthus roseus*
	Apocynaceae	Adenium	Adenium	*Adenium obesum*
	Malvaceae	Joba	China Rose	*Hibiscus rosa-sinensis*
	Oleaceae	Sheuli	Night-Flowering Jasmine	*Nyctanthes arbor-tristis*
	Solanaceae	Hasnahena	Night-Blooming Jasmine	*Cestrum nocturnum*
	Nyctaginaceae	Baganbilash	Bougainvillea	*Bougainvillea spectabilis*
	Portulacaceae	Time Phul	Ten o'clock	*Portulaca grandiflora*
	Portulacaceae	Puttolika	Common Purslane	*Portulaca oleracea*
	Nymphaeaceae	Water Lily	White Water Rose	*Nymphaea alba*
Cactus (4)	Cactaceae	Night Queen	Orchid Cactus	*Epiphyllum oxypetalum*
	Cactaceae	Ball Cactus	Ball Cactus	*Parodica magnifica*
	Cactaceae	Castle Cactus	Fairy Castle Cactus	*Acanthocereus tetragonus*
	Cactaceae	Zebra Cactus	Haworthia Cactus Zebra	*Haworthis fasciata*
Forest (4)	Arecaceae	Palm	Yellow Palm	*Dypsis lutescens*
	Cycadaceae	Cycas	Cycas	*Cycas circinalis*
	Moraceae	Pakur	Sacred Fig Tree	*Ficus religiosa*
	Moraceae	Bot	Banyan Tree	*Ficus benghalensis*
Leaf (20)	Asparagaceae	Kolshi Udvit	Cordyline	*Cordyline fruticosa*
	Asparagaceae	Spider Plant	Spider Plant	*Chlorophytum comosum*
	Asparagaceae	Apple Patabahar	Lucky Bamboo/Fortune Tree	*Dracaena sanderiana*
	Asparagaceae	Dracena	Dracaena	*Dracaena umbraculifera*
	Asparagaceae	Dracena	Palm Lily	*Cordyline fruticosa*
	Asparagaceae	Dracena	Striped Dracena	*Dracaena deremensis*
	Lamiaceae	Sobuj Coleus	Coleus	*Plectranthus scutellarioides*
	Lamiaceae	Bideshi Pudina	Coleus	*P. amboinicus*
	Lamiaceae	Shikay Gach	Swedish Ivy	*Plectranthus verticillatus*
	Araceae	Patabahar	Dumbcane	*Dieffenbachia amoena*
	Araceae	Kochupata	Elephant Ear	*Caladium bicolor*

	Araliaceae	Neem Patabahar	Ming Aralia	*Polyscias fruticosa*
	Araliaceae	Aralia	Aralia Oak Leaf	*Polyscias guilfoylei quercifolia*
	Araliaceae	Gobre Patabahar	Black Ming Aralia	*Polyscias quilfoylei blackie*
	Euphorbiaceae	Patabahar	Croton	*Codiaeum variegatum*
	Euphorbiaceae	Patabahar	Jacob's coat	*Acalypha wilkesiana*
	Euphorbiaceae	Patabahar	Jacob's coat	*Acalypha wilkesiana* var. *godseffiana*
	Euphorbiaceae	Red Leaf	Smoke Tree/Copper Plant	*Euphorbia cotinifolia*
	Commelinaceae	Shikay Gach	Inchplant	*Tradescantia zebrina*
	Marantaceae	Patabahar	Prayer Plant	*Calathea undulata*

Plate 1: *Roof of a home (71 N. S. Road, Kushtia, Bangladesh)*

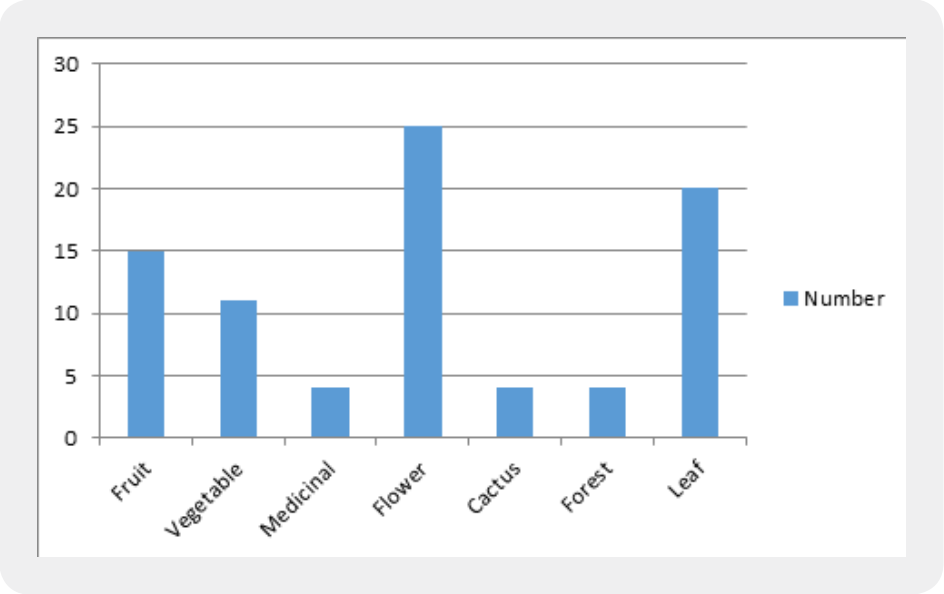

Figure 1: *Category of the rooftop plants*

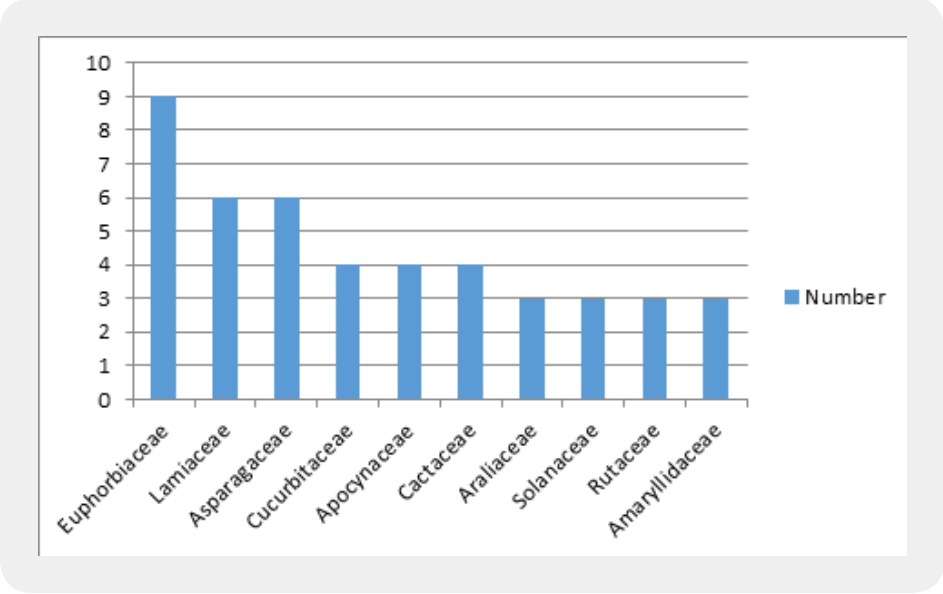

Figure 2: *Observed the number of the families of those plants*

Discussion

Rooftop farming can reduce the temperature of roofs and the surrounding air that contribute to overall cooling a local climate [1] and can help reduce urban heat island effect [2]. Roof farms can also absorb carbon emissions and noise [2,3]. Rain water is captured and absorbed by the plants and overflowing impact on infrastructure is reduced [1]. This kind of farming can easily offer employment to people [4]. Farming in

rooftops help to increase biodiversity and provide habitat for variety of insects and birds [5]. Rooftop urban farming also offers many environmental and social benefits to high density urban cities like Hong Kong [2]. It can be contribute to the development of urban food systems by increasing local food production, meet the nutrition demand of the people by access to nutritious food, mitigation of air pollution, increasing storm water retention capacity, improvement of public health, enhancement of the aesthetic value of the urban environment and enhancement of community functions [6]. In Dhaka, one of the world's fastest growing mega cities, open and cultivable land has been converting to built-up area indiscriminately and thus agricultural land has been decreased at an alarming rate [7]. It is estimated that 10000 ha space of Dhaka city can be brought under rooftop farming and the residents of the city can taste fresh vegetables as well as over 10 percent of the demand can be fulfilled through rooftop farming [8]. A survey shows that most of the roofs of Dhaka city are suitable for gardening and do not require major improvement work, sometimes only need some modifications [9]. The purpose is to create the least possible ecological footprint and to produce the minimum quantity of pollution possible, to efficient use of land, compost used materials, recycle it or convert waste-to-energy and to make the city's complete contribution to climate change minimal [10]. In recent years, some people in Taiwan are trying to develop effective growing methods for promoting rooftop farming [2]. Though there are numerous benefits of rooftop farming, rooftop gardeners are facing several challenges, too. Slope of the roof, load veering capacity of the building and root etc. are important considerations. Roof weight can increase by as much as 30-950kg per square meter roof gardens depending on depth of soil, when saturated by heavy rain. Keeping the soils healthy and productive may also be challenging as rooftop structural soils are different from ground bed soils [11]. Starting gardening without proper training may lead to frustrating outcomes, which might result in unwillingness of the people in initiating new projects [9]. Tokyo is the first city to mandate building vegetation that must constitute 20% of all new construction. Recently, urban agriculture and food security have attracted considerable interest in many cities of Canada. The green roof by law passed in 2009 states that all new buildings over six stories tall and with more than 2000m^2 of floor space must have minimum 20 percent rooftop greenery [12]. In Nepal, currently a limited number of households are practicing rooftop gardening with the support of NGO's, municipalities and the Ministry of Agriculture Development. Practitioners were interviewed to explore their motivation, present condition, benefits and problems faced and other experiences. Pesticides were used for two years at first but now no pesticides are used as problem of pests is found in the plants. To save the roof from getting damped, the practitioner places drums and tubs over the brick. Pesticides are sometimes used in the garden to save plants from the attack of the insects but the use is very little. Sometimes organic fertilizer is used in little amount. Birds and vegetable have an ambivalent relationship and many birds are important predators of garden pests.

Recommendations

1. Proper training and awareness program should be initiated to spread the knowledge of rooftop farming. In addition, if possible to supply some field note books on nursery plants will be helpful.

2. Cheap fertilizer or manure is very important for growing those flowering, fruits, vegetables, and forest plants. In this case, vermicompost manure is the best for crops in the land or on roof.

3. For preserving better quality of plants there is no shortcut of research. Universities of Bangladesh can give effective initiatives for the betterment of nursery plants.

4. If government provides incentives regarding the price of plants and necessary equipment, it may encourage people to initiate rooftop farming either those farms are large or small.

5. Enhance everybody for making gardening for the conservation of biodiversity. We should initiate our children for assisting in gardening.

7. Should implement about the significance of plants in text book of the students.

8. Give loan for the small scale farmers.

9. Most of the roofs of Dhaka city are suitable for gardening, some modifications are always necessary to make it more suitable for this farming. There should also be provision to provide water taps in different location on the roof and netting to protect plants and fruits from birds.

Conclusions

Rooftop farming can reduce the excess temperature within the room. In addition, it can also absorb carbon emissions and noise. This kind of rooftop gardening can easily offer employment to people. Farming in rooftops helps to increase biodiversity where variety of insects and birds may come. It can be contribute by increasing local food production and nutritious food. In Dhaka Bangladesh, one of the fastest growing mega cities, cultivable land has been converting to industrial area and thus agricultural land has been decreased at an alarming rate. A survey shows that most of the roofs of Dhaka city are suitable for gardening. Slope of the roof and load capacity of the building are important considerations. Without proper training during rooftop gardening may lead to frustrating outcomes. Many tubs, drums, and unwanted pots are available in the garden to cultivate flowers, vegetables, fruits, forest, medicinal, and fancy types of plants. Cabbage and cauliflower can cultivate on the roof by bedding method. Seasonal fruits like malta, orange, mango, pomegranate, banana can cultivate easily. Maintenance cost for gardening is not burden to the farmer. If we take good management for all plants need not use any remarkable on those plants. To save the roof from getting damped, all drums and tubs should place over the brick. Vermicompost fertilizer is good and safe for rooftop gardening. Cocodust is becoming popular in Bangladesh for cactus type plant. Organic fertilizer can be used in little amount. Birds are important predators of garden pests. Sometimes farmers get low quality plants and thus they do not get desirable production at all.

Acknowledgement

71 N. S. Road, Kushtia of Bangladesh is the mid place of this town. The owner of this house Most. Fatema Khatun has four children. 1st son is Md. Alamgir Kabir (Milon) who passed his foreign life in Saudi Arabia. After his coming in Kushtia, Bangladesh he joined in a printing press. He is very curious for keeping plants. On his house's roof, now he is cultivating many plants. Already he has invested around 50,000 taka for this rooftop gardening. The writer of this article is the second brother of Alamgir Kabir. Author got lots of information from him about this article. Mst. Hafiza Khanam (Rushi) who is the wife of Milon is very curious for planting. She is very sincere to care all of the plants and always gives company with her husband (Milon) for collecting those plants from various places of Bangladesh. Milon always tries to attach with agriculture officer of Kushtia. When he faces troubles especially pest attack, he discusses with him for solution. Milon is very honest, sincere, dedicated, painstaking, skillful, knowledgeable, and optimistic about

his rooftop gardening. His dream is, he will make it in a befitted manner timely and he hopes will inform television channel for telecasting his rooftop gardening.

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