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"HUGELKULTUR" DESIGN, BENEFITS, AND DRAWBACKS

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ABSTRACT

The near future is likely to face a major food and resource scarcity attributed to climate change, increasing population, and inefficient resource management. Resorting to alternatives, which would address such issues, offer a possibility for a sustainable future. Yard trimmings and disposed wood occupy a significant portion of municipal waste. These could be composted and used as agricultural grounds for food production through the adoption of "Hugelkultur". Hugelkultur is a subset of Permaculture: "permanent" and "culture", rediscovery of a pre-industrial farming practice capable of sustaining populations. A short literature review was conducted to answer preliminary questions on the construction, benefits, and challenges in readopting this old technique in the contemporary system. Hugelkultur involves the use of a log base, followed by a layer of branches, twigs, leaves; the mound is then covered with a layer of soil where crops are planted. The system can recreate a natural forest system to provide nutrients to the plants on decomposing. Its benefits, as a sustainable practice, include self-sustenance, soil moisture retention, improved soil fertility, and utilization of woody debris. However, it is a labor-intensive practice, and the huge quantities of desired debris pose a major challenge to the culture. Also, the paucity of literature and scientific data presents a huge drawback while adopting this system. Extensive study and research on the model are thus required to achieve a wider adoption.

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INTRODUCTION

Owing to the facilities and technologies, human lifespan and population are projected to expand tremendously in the future decades. With no changes in the fertility rate (2005-2010), the global population would exceed 25 billion by 2100 (Cleland, 2013). Additionally, climate change has drastically reduced arable land and water resources. Water and food scarcity are therefore key challenges due to climate change patterns (Misra, 2014). Thus, long-term sustainability depends on interventions to feed the growing population. The burden of food uncertainty should be transformed to create resilience (Sheeran, 2010).

Adams, *et al.* (2013) reported that 13.3 million tons of yard trimmings wastes (leaves, grass clippings, twigs, and tree trimmings) are landfilled every year. This presents a need for sorting ways to manage such municipal solid wastes. Additionally, desertification has been a big problem that impacts agricultural productivity and water availability (Laffoon, 2016). Hugelkultur can address such issues by retaining moisture in the soil, enhancing microbial populations, improving aeration, and soil fertility (Adams *et al.*, 2013).

WHAT IS HUGELKULTUR?

Hugelkultur (Etymology: German; hugel, hill; kultur, culture) varies within the permaculture method (Laffoon, 2016). It is a method of building garden and landscape beds using woody material, garden debris, and soil arranged in long, tunnel-shaped mounds (Chalker-Scott, 2017). The system adopts a short-term perennial production using decaying wood, which is allowed to decompose over time (Spirko, 2015). It is widely believed that the permaculture technique that is promoted by permaculturists today was initially a tradition from Eastern - Europe (Glore, 2015). The method employs rotting wood as a foundation to convey the growing plants with nutrients and water sources.

Austrian permaculturist Sepp Holzer is said to be the father of Hugelkulture/ mound culture. The tradition was common in Europe for years but is a novice discovery to many other nations (Palmer, 2013). Holzer described the practice as raised beds made to imitate the nutrient cycling in nature through wood decomposition and high water-holding capacities (WHC) of organic materials, accompanied with an improved structure, drainage, and space efficiency (Laffoon, 2016). In simple terms, it demoted piles of woody debris or other detritus under a layer of soil.

In this method, raised beds are constructed with biodegradable materials, such that they mimic natural microtopography. Decomposable materials are used to supply nutrients back into the soil through the process of natural decomposition (Shebitz *et al.*, 2017). This process encourages nutrients (released during decomposition) uptake by plants naturally and sustainably (Feineigle, 2012). Hugelkultur is an example of *in situ* co-utilization technique that is about a century-old technique; it involves burying woody waste, grass clippings, and other decomposable wastes followed by cultivation over the resulting hill/mound (Holzer, 2004; Adams *et al.*, 2013).

Hugelkultur is a self-maintaining system that is a suitable method to dispose woody debris, especially when debris burning is prohibited due to environmental hazards (Chalker-Scott, 2017). The technique is an alternative to flatland culture intended to have multifold benefits. Thus, hugelkultur is an aid in source reduction of yard trimmings fostered by an incentive of improving soils in the gardens (Adams *et al.*, 2013). Hugelkultur is one of the several methods

of producing compost in an environment-friendly way that minimizes solid waste generation, preventing them from ending up in landfills, reducing greenhouse gas emissions, decreasing soil erosion, and increasing soil carbon storage. (Kaushalya *et al.*, 2016).

THE HUGELKULTUR DESIGN

Hugelkultur is a unique Central European-style raised bed that uses rotting woods as its foundation (Soleil, 2012). The design can be as simple or as involved as the following (Govind et. al., 2015):

- Space-availability to implement the design
- Maintenance: the labor required for maintenance
- Material cost: the monetary loss or gain after implementation
- Water efficiency: conservation of water in the design
- Innovative techniques: sustainable methods used
- Visual appeal: aesthetic factor in a university setting
- Composting method: design that feeds the crops
- Waste management: the way organic waste gets discarded
- Reduce-Reuse-Recycle: the overall conservation in the design.

Hugelkultur being one of the variations of permaculture is particularly well suited for areas with compacted soils, poor drainage, limited moisture, etc. Hugels are layered piles of wood debris or similar organic matter under a layer of soil (Figure 1), above which seeds are sown (Laffoon, 2016).

The steps involved in the creation of a hugel mound involves:

1. Gather materials for the hugel construction including wood for the base of hugel including fallen logs, twigs, fallen leaves, clippings, branches, etc.
2. Dig the grass out of the area where the garden is intended to be constructed. However, do not discard the soil or the sod from this location because it is going to be used again.
3. Dig a shallow trench in the desired location, make sure the trench is deep enough and wide enough to fit the number of logs prepared for this gardening project.
4. Place the first layer of rotting wood on the hügelkultur bed.
5. Add a layer of branches and twigs that are broken and laid in a weave framework.
6. Optionally, a layer of wood ash for extra potassium, bits of biochar can be added. Sods such as straw, grass clippings, and weeds can be added as a layer. For an elevated Nitrogen, add some urine and for Calcium, add crushed eggshells periodically to help balance the acidity of clay sods (Soleil, 2012; Feineigle, 2012).
7. Add nitrogen-rich composted manure. This is where the sods are added back to the garden, helpful for year one because it gives a nice layer of nitrogen-rich matter (from the grass and roots), and it gives 3-4 inches of high-quality topsoil for the roots to spread.
8. It is best to cure the bed prior to sowing, with the addition of a layer of upturned soil enough to cover the previously laid materials
9. Water the layers well.
10. Add a layer of mulch to top off with available organic: branches, straw, hay, wood chips, green vegetation, grass clippings, etc. (Alonso, 2014). This is considered a crucial step for the first year planting. The thicker the layer, the more versatile are the crops grown. It is advisable to place a thicker layer on the top of the hugelkultur bed, with a thinner layer on the sides.

An optimal hugel is about 5 feet x 2 feetwide x 6

feet wide, creating a 45-degree angle for good aeration (Palmer, 2013). Sepp Holzer advises building the mounds slightly higher than the height of the person who tends the mounds (https://richsoil.com/sepp-holzer/sepp-holzer-permaculture.jsp). Such mounds tend to have an average lifespan of five to six years, which needs to be rebuilt (Chalker-Scott, 2017).

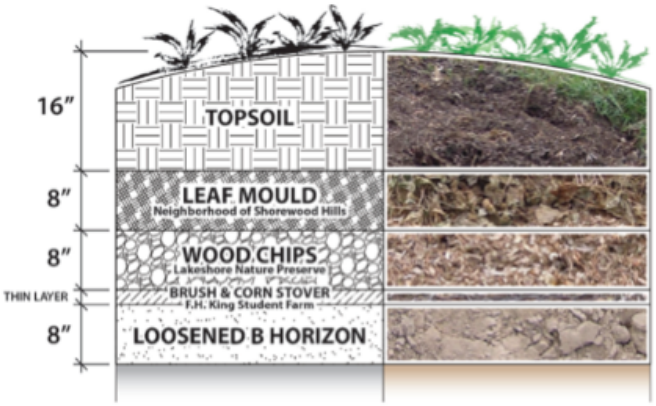

Figure 1. An illustration of the hugelkultur raised bed. (Source: Adams *et al.*, 2013)

TYPE OF WOOD USED

Hugelkultur utilizes the nutrients from decomposing woody debris. The selection of debris here plays a detrimental role in the process and success of the implementation. The wood on breaking down creates air pockets where bacteria and mycelium invade further hastening the process as a self- tilling system (Feineigle, 2012).

The system can serve as a beneficial design if hardwood is used as a basis (Govind et. al., 2015). Some recommendations for the selection of the woody material include (https://www.treehugger.com/hugelkultur-the-ultimate-raised-garden-bed-4863030):

- Alders, Apple, Cottonwood, Poplar, Willow (dry), and birch are known as excellent woods for hugelkultur.
- Black cherry (only well-rotted), Camphor wood (use only well-aged), Cedar, Juniper, Yew, Eucalyptus (slightly anti-microbial), Osage orange (exceptionally resistant to decay), Pacific Yew (exceptionally resistant to decay), Pine, Fir, Red Mulberry (exceptionally resistant to decay) work fine with hugel beds
- Cedar/ Juniper/ Yew: They are long-lasting and loaded with natural properties. Cedar needs to be broken down before new plant roots reach it.
- Fir and Pines: they are hardwood with some levels of tannins which are expected to reduce after a few years. Their green needles are full of ascorbic acids (Vitamin-C) and acidify soils. So, they could be useful under some circumstances, around acid lovers like Blueberries and Azaleas but could be detrimental in other areas if it is allowed to swing the pH too far to the acid site.
- Black locust, cherry, black walnut, and old-growth Redwood are not preferably used as Black locust rots very slowly, Black walnut is considered toxic, cherry is toxic to animals, redwood compost can prevent seed germination; thus should be avoided. However, well-rotted cherries can be used.

It is necessary to note that wood is high in carbon and will consume nitrogen for a preferable C:N ratio, while decomposition occurs. This could lock up the available nitrogen and in turn devoid plants of Nitrogen. However, well-rotted wood is considered better than slightly aged wood to avoid nitrogen fixation.

BENEFITS

Hugelkultur has numerous features that fit with the definition of sustainability (Govind et. al., 2015). It is a rediscovery of non-conventional old food production traditions, amalgamated with modern innovations. Hugelkultur is often acknowledged for its nutrient cycling properties and maximisation of efficiency. The system creates all sorts of microclimates making it possible to grow more in the same acreage.

Some key benefits could be summarised as below:

- Self-sustaining: Hugels can be used for many succeeding years as a no-till agricultural system with a lower maintenance system (Laffoon, 2016).
- Flexibility in building materials: A variety of different organic materials and wood debris can be used.
- Hugels mimic trees for which the varying elevations and shapes increase the incidences of the diversity of animal and plant habitat niches.
- Hugels are raised mounds and are easier to maintain water.
- Hugels can make use of other indigenous media as a very sustainable, profitable system (Laffoon, 2016).
- Hugels are three-dimensional, creating additional space for growing plants, and increase the growing capacity of plants (Haley-house, 2016; Chalker-Scott, 2017).
- The nutrients released by woody debris provide a food source and habitat for beneficial microbes, decomposers, and beneficial insects.
- It is optimum for landscapes and gardens, where woody materials are readily available, and benefit its mother soil (Chalker-Scott, 2017).
- Warmer soil leads to a longer growing season, due to the heat given off during decomposition. (Chalker-Scott, 2017).
- Diverse crops can be grown as the mounded beds extend the growing season, improve sun exposure, and foster the creation of microclimates that support a great range of plants.
- Hugels involve no digging, no fertilizers, and less irrigation, protecting the quality of the soil.
- Wood, during decomposition, act as a sponge and creates a reservoir during the dry season that helps combat desertification (Laffoon, 2016).
- Hugels apply to small gardens as well as big farms, and they are customizable based on resources.
- Being a green alternative to burning of woods, they do not harm the environment and can lower carbon emission (Govind et al., 2015).
- Hugels have an aesthetically pleasing view and are socially acceptable (Govind et al., 2015).
- Plant cover is established soon, reducing soil erosion (Laffoon 2016; Ocampo et al., 2020).

CHALLENGES

Challenges arise parallel with opportunities. Hugels have a few negative features.

- The arrangement of resources is among the most difficult features in the Hugelkultur practice (Laffoon, 2016).
- It is labor-intensive to create it and might involve the use of big machinery to carry and bury wood into the soils (Govind *et al.*, 2015).
- Availability of suitable woods can be a problem (Govind *et al.*, 2005).
- Resorting to alternative sources of organic material as the base of a hugel bed without slow decay benefits of woody materials could pose challenges in the longevity of the hugels (Laffoon, 2016).
- Agricultural yield might not be met to an absolute degree.
- Nutrient-rich organic matter could be overused and the release of excessive nutrients could contaminate soil and water habitats (Chalker-Scott, 2017).
- Weeds are identified as potential problems that colonize mounds unless mulch is used (Chalker-Scott, 2017).
- Mounds collapse over time, requiring rebuilding (Chalker-Scott, 2017).
- Soil contamination could arise from heavy metals or other pollutants can be a problem for some home gardens (Chalker-Scott, 2017).
- Based on estimations, even the largest Hugel

beds would be insufficient for a small family (Chalker-Scott, 2017).

- High carbon-rich wood could result in nitrogen immobilization, which is responsible for loss in soil fertility (Adams et al., 2013).

CONCLUSION

Most of the benefits of hugels are in alignment with that of other permaculture services. The potential from hugels is considered beneficial for production, diversity, soil restoration, and woody debris management. However, without enough database and field trials, the data to support all the concepts are insufficient. In order to make up for the paucity in research, especially on hügelkultur as sustainable agriculture, more quantitative research on the water, nutrient, and restorative capacities of permaculture need to be conducted.

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