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Deep, Raised Beds to Advance Ergonomics and Food Access

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Photo 1: Deep raised bed system

Background:
Installation of an outdoor, raised or elevated bed system can result in high-yield production with inherent weed and pest suppression, which reduces long-term labor needs and frequent maintenance. This reduction of labor also decreases the occupational risks associated with agricultural work that comes from repetitive physical exertion. Protecting agricultural workers by minimizing uncomfortable working conditions is critical to maintaining the current workforce and promoting interest in the field.

Raised or elevated garden beds are agricultural systems built above the ground versus directly in the soil (**Photo 1**). They can be built to any height or width and are often made out of materials such as food, bricks, plastic, concrete, etc. For the purpose of this article, we collaborated with Honolulu Community College's Carpentry Technology Program and built raised beds at an adult accessible height of 3 feet to minimize postural strain induced by repetitive bending to plant, weed, harvest, service, etc.

In vegetable production, much of the manual labor requires workers to remain in awkward postures and positions, often sitting, squatting, or bending for extended periods of time while performing various tasks such as harvesting, weeding, and seeding, transplanting, etc. Adverse working conditions can increase the occupational risk factor of agriculture, causing discomfort and negative physiological effects, such as chronic back issues. Thus, the utilization of raised garden beds as an ergonomic intervention can reduce risk by promoting improved workplace efficiencies and decreasing physical overexertion.

Elevated raised beds also allow for increased food production and access in locations where land is limited such as schools, backyards, abandoned lots, parks, community centers, etc.

Benefits

There are many benefits to designing and constructing a raised garden bed systems. The labor needed to maintain the growing area is reduced, as being off the ground provides a natural barrier that prevents and minimizes nearby weeds and pests from colonizing the beds, decreasing the risks of overexertion and discomfort associated with prolonged weeding and utilization of heavy chemical treatment options.

Photo 2: Green waste, shredded cardboard, and compost.

Another benefit of this system is the potential for large amounts of food being produced in a small area or areas not typically suitable for food production. In this example, raised beds were constructed at the Urban Garden Center in Pearl City in a location which often struggled to produce viable outcomes. Beds were built 4' wide, 3' tall, and 20' long, allowing for 80 square feet of growing area. Bottoms were filled with green waste and shredded cardboard material (**Photo 2**). The top growing area consisted of compost, potting mix, coconut coir and a slow release fertilizer.

Not only was the height beneficial for workers, but the depth allowed for the planting of deep rooted crops, such as ginger, turmeric, kalo, and other root vegetables, increasing the versatility of the bed. A recent pilot test of this system resulted in a modest harvest of turmeric (BKK) on 2/25/25 which yielded approximately 70lbs of produce from two rows per bed with minimum pest and weed pressure. Kirk et al. (2022), estimated marketable turmeric yields to be 0.38-1.66 kg (0.83-3.65 pounds) of cleaned marketable fingers per plant, with BKK

being the lowest yielding variety. Tumeric yields from this initial deep, raised bed system were 0.875 pounds per square feet (**Photo 3**).

All turmeric and kalo grown in these systems were harvested and donated to a local food distribution organization.

Lessons Learned and Future Considerations

Construction of raised beds can vary in height and design. Filling a deep, raised bed system 3' in height can be costly. For this project, green waste was used for the bottom later, followed by shredded cardboard, compost, and a potting mix layer. As decomposition of the green waste occurred, more media was added. Compost is the most economical option and the best choice for on the ground systems which can bear the weight. Purchasing media would be the biggest investment. Access to an onsite source of compost would reduce cost significantly.

Modifications to the deep bed system can be made to create ergonomically designed units, such as raising the bottoms on raised bed systems to be comparable to standard counter top heights of 36 inches (**Photo 4**).

For example, a shallow 6" grow bed, above ground system was built over a hallow tile frame at 32" in height. Former hydroponic beds were re-purposed and filled with potting mix, coconut coir and granular fertilizers. A 128 square feet growing area yielded 200 pounds of radish and leafy greens which were produced by volunteers at a comfortable working height (**Photo 4 & 5**).

Photo 3, 4 and 5: Modified raised beds to be comparable to standard counter top heights of 36"

Shorter beds may be more economically conservative and accessible to children, but the ergonomic benefits of the taller, adult-height beds are virtually eliminated. While taller beds can be made accessible to children through the use of step stools or platforms, shorter beds cannot be made accessible to adults with the same ease.

Adoption of deep, raised beds can help to increase food production and advance food security throughout the state, while minimizing the physical toll on the workforce. However, the upfront labor and costs needed to construct 3' tall raised garden beds are relatively high and should be considered. Labor for these trials were provided free of charge by Honolulu & Leeward Community College, S/H Department of Education and Corrections Industries. Deep, raised bed system also can be subject to coconut rhinoceros beetle (CRB) breeding. Screen was placed on the top of the beds as a deterrent (**Photo 6**). Past estimates show materials can run up to $1,667 for 80 square feet (240 cubic feet) of growing space. Elimination of the largest expense, compost or potting media, can drop cost to $821.

According to the 2021 Hawaii Tropical Fruit and Crop Report, the price of turmeric is $5.37/ pounds (**Photo 7**). A return on investment can be seen within a year or two by growing high value crops such as turmeric, utilizing a high intensity planting, or growing multiple crops a year in these systems. Investing into agricultural workers' health and workplace ergonomics may promote a stronger and sustainable workforce for years to come.

Photo 6: Screen being used as a physical barrier against CRB. Photo 7: A 70 pound yield from two rows of turmeric grown in a deep raised bed could yield a marketable price of $376.

References

Kirk, E., Tavares, K., Calpito, J., Wages, S., Bingham, J.P., Ahmad, A., Uyeda, J., Collier, E., Radovich, T. 2022. Assessing Yield

and Curcuminoid Content for 6 Varieties of Turmeric (Curcuma longa) Grown on Kaua'i. Hanai'Ai Newsletter Volume 45 Jan | Feb | March 2022. Sustainable and Organic Agriculture Program, University of Hawaii at Manoa. Available online: https://gms.ctahr.hawaii.edu/gs/handler/getmedia.ashx?moid=71123&dt=3&g=12

Sugano, J., A. Ricordi, R. Fisher, R. Mercado and P. Chung, Construction of Deep Raised Bed Systems (White paper), August 2024. Available online: https://drive.google.com/file/d/1YhVjFWW6Du-YfmEzL7sPye_QRra6YqdP/view?usp=sharing

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