Spacing Calculator for Biointensive Mixed Plantings

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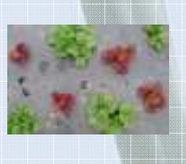
BACKGROUND

Mixed planting, or companion planting, can offer benefits over monocultures:

- Mixed crops often have higher yields than monocultures because different species use different resources, making more efficient use of land.[1]
- Mixed plantings often have fewer pest problems than monocultures because pests have a harder time finding suitable hosts, or because diverse plantings provide better habitat for natural enemies.[2]
- Diversity helps reduce risk. Promoting biodiversity is a stated goal of the USDA's national organic standards.[3]



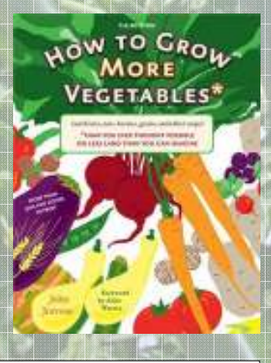
Some crops are commonly grown in mixtures:

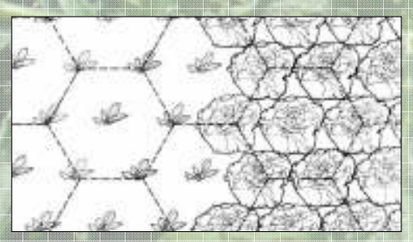
- Hay is usually a mix of grass and legume species.
- Shade-grown coffee plantations mix low-growing coffee bushes with trees.
- Backyard gardeners often mix vegetables, herbs, and flowers in the same bed.

Although mixed plantings are common, practical resources for those who grow mixed crops are few; production guides and extension materials often assume monoculture.

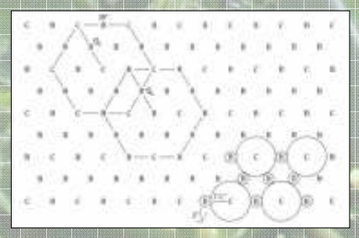
BIOINTENSIVE MINI-FARMING

- *How to Grow More Vegetables…* by John Jeavons[4] advocates a gardening system called "biointensive mini-farming," which consists of:
  - deeply-cultivated ("double dug") beds amended with compost
  - high-density mixed plantings
  - offset rows
    (every plant is the same distance from its six nearest neighbors, creating a beehive pattern of hexagons)





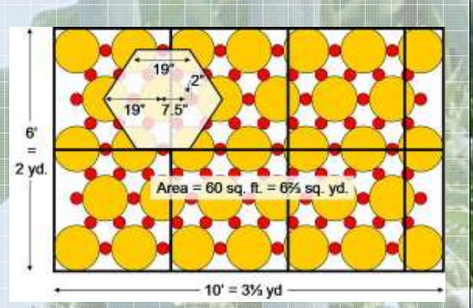
Hexagonal spacing diagram from *How to Grow More Vegetables...* The spacing between plants is equivalent within and between rows, forming a hexagonal lattice of tightly-spaced plants.



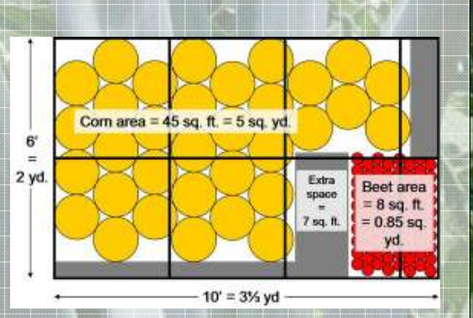
For plant spacing in mixtures, Jeavons uses the mean of his recommended plant spacings for component crops. For example, he suggests that corn plants in monoculture be spaced 15" apart, and beet plants 4" apart, so corn and beet planted as a mixture are spaced 9.5" ([15+4]/2) apart.

THE PROBLEM

- Mixed plantings spaced according to Jeavons' recommendations require *more* land than separate monoculture beds when:
  - One crop is much larger than the other
  - The smaller crop makes up a larger proportion of the plants than the larger crop
- If mixtures use resources more efficiently than monocultures they should not need more space.



Two-crop companion planting diagram with dimensions, adapted from *How to Grow More Vegetables...* Corn plants are represented by yellow circles; beets are red. A mixture of 33 corn plants and 80 beet plants requires 60 sq. ft.



The same number of plants grown in two pure stands would require only 53 sq. ft. of bed space, leaving 7 sq. ft. for another crop

A SOLUTION

- An equation[5] can be used to calculate between-plant spacing for mixtures (s_{mix}) from:
  - The recommended spacing for each component crop in pure stands (s_A, s_B…)
  - The proportion of the mixture accounted for by each component crop (p_A, p_B…).

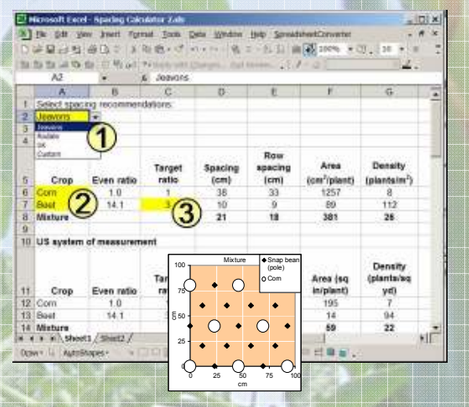
$$s_{mix} = \sqrt{p_A s_A^2 + p_B s_B^2 + \ldots}$$

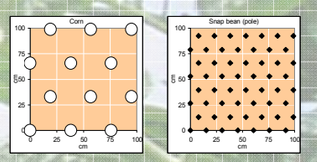
- Mixtures spaced using this equation use the same amount of land as if the component plants were divided into pure stands

TOOLS BASED ON MIXTURE SPACING EQUATION

SPACING CALCULATOR SPREADSHEET

- Select options from drop-down menus:
  - 1. Use pure stand spacing recommendations from Jeavons,[4] Rodale Institute,[6] University of Kentucky Extension,[7] or another favorite source
  - 2. Choose a primary and secondary crop (spreadsheet limited to two-crop mixtures)
  - 3. Select the number of secondary crop plants per primary crop plant in mix (crop ratio)
- Spreadsheet calculates (in metric and US measurement units):
  - Spacing between plants
  - Spacing between offset rows
  - Crop ratio that dedicates an equal amount of land to each crop
  - Planting density for component crops and mixture
  - Much more…



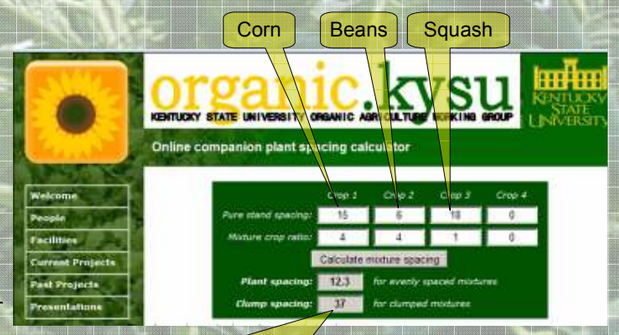


The spacing calculator spreadsheet generates planting diagrams for mixtures based on pure-stand plant spacing for component crops.

Download: http://organic.kysu.edu/CcompanionSpacing.shtml

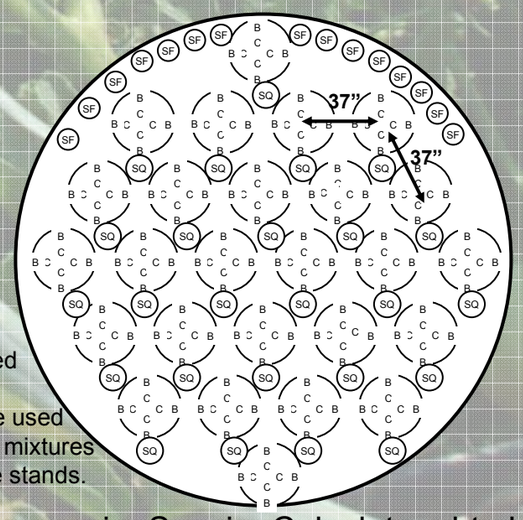
ONLINE SPACING CALCULATOR

- Requires
  - Recommended spacing for pure stand (up to four crops)
  - Relative proportion of crops in mixture
- Delivers
  - Between-plant spacing for evenly-spaced mixture
  - Between-clump spacing for clumped mixture



If each hill has 4 corn plants, 4 bean plants and 1 squash plant then hills should be spaced 37" apart.

Example: The Wampanoag people traditionally planted circular gardens of corn and beans in clusters of four in evenly-spaced mounds. A squash plant was grown by each mound. The online spacing calculator can be used to calculate inter-clump spacing for clumped mixtures like this from recommended spacing for pure stands.



Try it: http://organic.kysu.edu/CompanionSpacingCalculator.shtml

1. P.A. Jolliffe. 1997. Are mixed populations of plant species more productive than pure stands? *Oikos* 80: 595-602.
2. H.A. Smith & R. McSorley. 2000. Intercropping and pest management: A review of major concepts. *American Entomologist* 40: 154-161.
3. USDA National Organic Program. 1999. Definitions – Regulatory Text. http://www.ams.usda.gov/NOP/NOP/standards/DefineReg.html
4. J. Jeavons. *How to Grow More Vegetables Than You Ever Thought Possible on Less Land Than You Can Imagine*. Ten Speed Press, Berkeley CA, 2006.
5. M.K. Bomford. 2009. Do tomatoes love basil but hate Brussels sprouts? Competition and land-use efficiency of popularly recommended and discouraged crop mixtures in biointensive agriculture systems. *Journal of Sustainable Agriculture* 33 (4). In press.
6. F.M. Bradley & B.W. Ellis. *Rodale's All-New Encyclopedia of Organic Gardening*. Rodale Press, Emmaus PA. 1992.
7. B. Rowell, R. Bessin, J. Masabni, J. Strang, T. Jones, & K. Seebold. 2006-07 *Vegetable Production Guide for Commercial Growers*. University of Kentucky Cooperative Extension Service, Lexington KY, 2007

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