https://visegrad.permakultura.sk/polycultures/

POLYCULTURE DESIGN TOOL
VEGETABLES AND LEAFY GREENS

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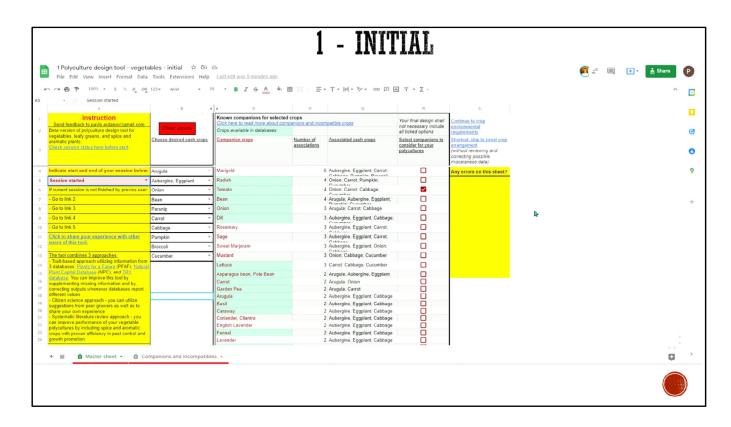
This is instruction to polyculture design tool for vegetables, leafy greens, and spice and aromatic crops that utilizes information from crop databases, literature review, and from a survey of growers. This is test version of a tool which is composed of 10 google spreadsheets.
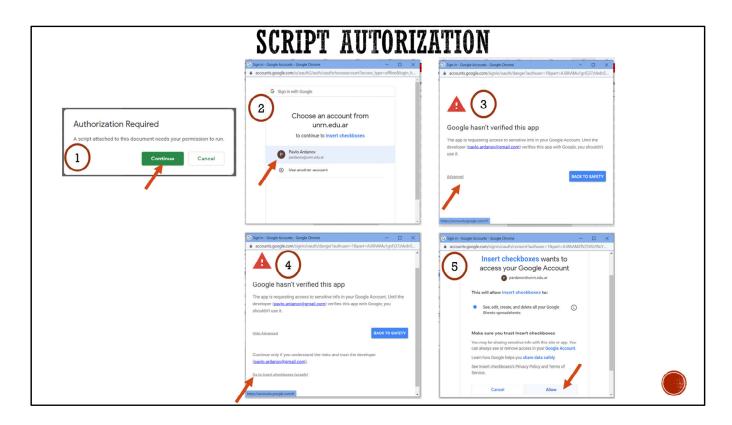
1 - INITIAL

We recommend you to sign to your Google account in order to be able to utilize action buttons.

On the first spreadsheet you need to check session status – if it is "Session finished" you can start your own session by changing status to "Session started" from a dropdown menu. Your session is stored until you mark that you finished session or up to 5 days. So you can continue your design over several days. There are 5 copies of a design tools for parallel sessions – we will create them and provide links after initial trial period and error check.
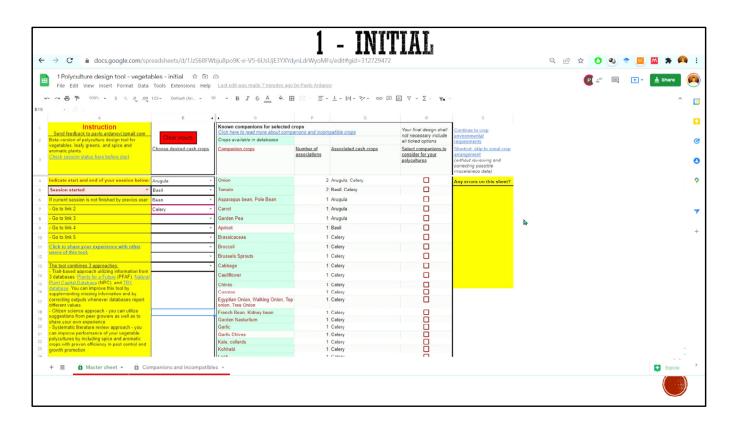
1 - INITIAL

As all spreadsheets store information from previous sessions, you need first to clear inputs of previous user by pressing red button.

You may be prompted to authorize script – detailed instruction is provided in the first row highlighted yellow.

Note that top rows and left columns might be "frozen" – in order to see the upper rows and left columns you need to place cursor into the upper left cells and move it down and right with arrow keys. Start your design by selecting up to 10 cash crops, that will be the focus for assembling your polycultures. Later on the tool will group your cash crops and selected companions by their environmental requirements, so at this point you can select whole range of desired crops irrespective of their cultivation requirements.

1 - INITIAL

Known companions of selected crops are displayed in the next column. Crops with detailed descriptions available in our database are highlighted green. Companions are ordered by the number of their associations with your cash crops. For example, onion can be the companion of arugula and celery, and tomato is known companion of basil and celery. Now tick boxes for all companion crops which you would be potentially interested to grow. During subsequent design steps you can decide which of them to include into your final polycultures.

You can click the link and open another sheet to review known compatible and incompatible crops. All design spreadsheets have the main design sheet and sheets with extra information. You can copy sheet link, paste it into your browser, drag it to open new browser window.

1 - INITIAL

And display your main design sheet and any additional sheets side-by-side for easier navigation, if you wish.

1 - INITIAL

Or you can always press link to return to master sheet in the same browser window.

1 - INITIAL

At the end of each sheet there is yellow field for your notes if you spotted any errors on current sheet.

From this first design spreadsheet you can continue to the next spreadsheet to review and if necessary correct crop environmental requirements or skip to the next step and proceed to zonal crop arrangement. Or you simply learn about known companions and finish using tool at this point (don't forget to finalize your s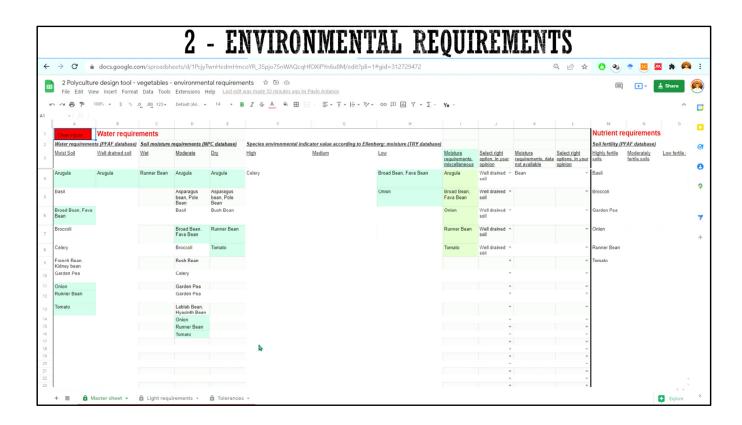ession in such case). Please wait till the next spreadsheet loads completely and finalizes initial calculations – at this point green progress bar disappears in the upper right corner. When you update information spreadsheet performs additional calculations – please wait till it finishes all the computations before moving to the next spreadsheet. The speed of calculations depend on processing power of your computer, and it takes more time for subsequent spreadsheets which process progressively more information.

2 - ENVIRONMENTAL REQUIREMENTS

In the second spreadsheet you review environmental requirements of selected crops and selected companions. As always, start from clearing inputs from a previous user. Different databases may report different values for certain crops – such crops are highlighted green as arugula here which is reported as crop for both moist and well drained soil by one database, but as crop for moderate and dry soil by another database. The tool automatically calculates the most popular options. In addition, you can report yourself respective trait values – your corrections are very useful to improve tool performance for subsequent users. In this sheet you review crop water, nutrient and soil requirements, and 2 more sheets are included to review light requirements and tolerances, if you design your polycultures for that specific conditions.
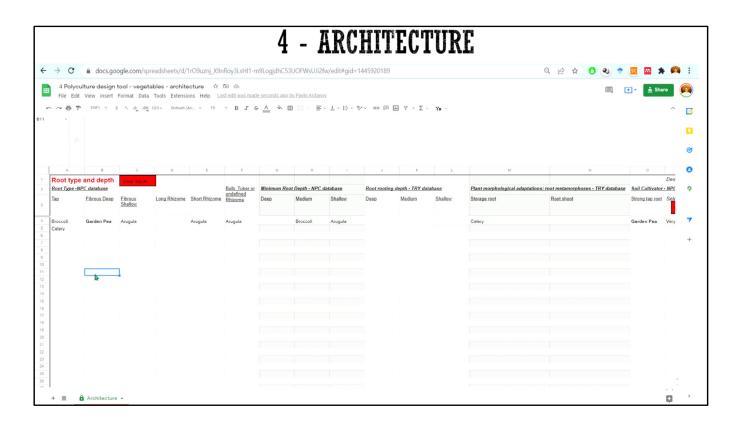
3 - ZONING

In the next spreadsheet you establish your initial polycultures by grouping selected cash crops and selected companions into so-called "Zones" with defined soil, light and stressors environmental conditions. You can define any number of conditions for 1 and up to 5 different zones. For each individual environmental condition that you define in each zone you can see the number of previously selected crops which meet this condition. To see the longer crop lists you can select respective cell and press "See crops" button or you can open crop list in a separate tab. Resulting lists for each zone are composed from those crops which you selected earlier and which meet all defined environmental requirements. Press "Update crop list" after selecting all sets of environmental criteria (or you can manually copy columns highlighted yellow to adjoining right columns with dropdown crop lists. You may select less stringent environmental criteria to include more crops into your polycultures.

Separate columns list those previously selected crops which does not meet your defined environmental criteria – you can return to the previous sheet and review environmental requirements of these crops. Or you can manually include them into desired polycultures by selecting from dropdown lists. Similarly, you can exclude any crops from any polyculture.

Next to crop lists for each polyculture you can also see known companions which were not automatically included (because they don't meet environmental criteria that you defined). Again, you can manually include any of them from dropdown lists based on

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your experience. Known incompatible crops are also visualized, and by default they are excluded from your polycultures, unless you manually select them from dropdown lists to keep them into respective polyculture. You can see detailed notes on crop incompatibility in a separate sheet.
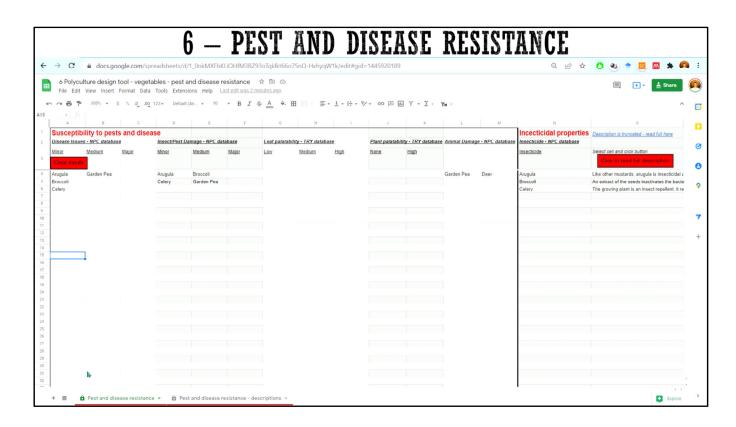
4 - ARCHITECTURE

In this spreadsheet you can review and correct information about plant architecture: root system type and depth, plant habitus, height and width, growth rate, lifespan, and growing season. If the length of description text exceeds cell length click button to read full description. You may click respective button to prefill miscellaneous crop report with most popular options which you can also correct manually. Also you can provide data for crops where information is absent by selection proper options from dropdown lists. From this sheet you can take shortcut and go straight to peers' suggestions and integration of spice and aromatic crops into your polycultures. Or you can continue to the following spreadsheet to review crop nutrient requirements.

5 — NUTRIENT CYCLING

Spreadsheet on nutrient cycling does not require user's input as it only represents information on your selected crops which is available in our databases. Here you can read which of your selected crops are nutrient fixers, accumulators of macro- and microelements, groundcovers and mulch makers. You can also see microbial associates of your crops. Separate sheet with detailed descriptions of some of these functions is available, where you can also provide feedback or correct information on individual crops.

6 — PEST AND DISEASE RESISTANCE

The sheet on pest and disease resistance also require no user's input. Here you can read information about crop susceptibility to pests, their biocidal properties and production of potentially biocidal compounds, as well as the information on attraction of pest predators and pollinators. A sheet with detailed description of some of these functions is also available.

7 - WEED POTENTIAL AND INTERCROPPING
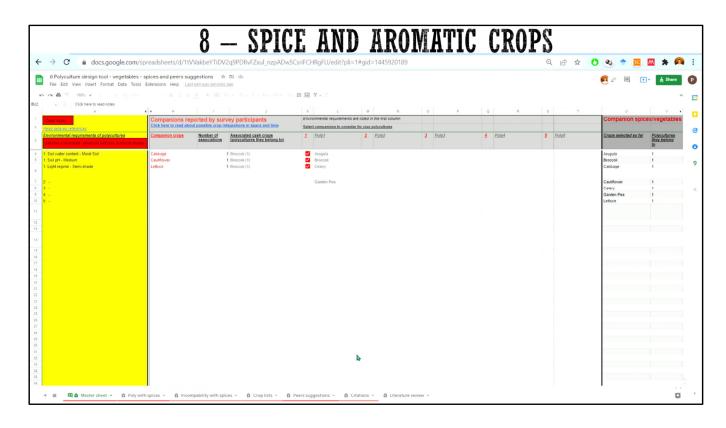
In the next sheet you can read about weed potential of selected crops and about different traits linked to seed dispersal and vegetative reproduction which might be linked to weed potential. This might be relevant in establishing rotations, where previous crop can potentially weed the following crop. Wherever miscellaneous reports are available you can prefill dropdown lists with the most popular options, manually correct it and supply information for crops where reports are not available. Another section is dedicated to intercropping considerations, such as allelopathy and phyto-social groups. The final sections refer to crop integration with livestock.

8 — PEERS' SUGGESTIONS

You can complement your polycultures with crops compatible to those crops that your selected earlier based on reports by other growers, namely German farmers practicing community-supported agriculture who participated in our survey. Left column of this sheet reminds you environmental requirements of your polycultures (in this example we work with single polyculture), and when you click the link to see possible crop integrations in space and time there will be an extra link to see initial crop lists of your polycultures before this design step. You can see what crop combinations containing your selected crops were reported by another growers, and how these growers combined crops in space and time – scroll right to see descriptions of different modes of crop combinations in space and time. Return to the main sheet and tick those crops that you want to include into respective polyculture.

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8 — SPICE AND AROMATIC CROPS

The next section refers to integration of spice and aromatic crops into your polycultures, which can serve for growth promotion, pest and weed suppression. These data are taken from systematic review of academic literature.

First part lists all crops that has been reported as associates to your polyculture components. You can read notes on separate spreadsheet as well as more detailed information including the mode and mechanism of interaction, and the size of effect. Please select from dropdown list what kind of description do you want to display: on all associates, or on control of selected pests, weeds or attracting pest predators. Tick boxes to include desired spice and aromatic crops into specific polyculture.
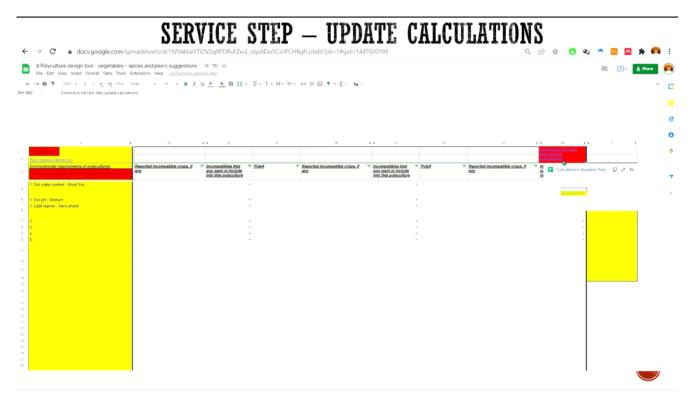
Next part allows you to include companion crops of spices which you added to your polyculture in a previous step. Here again you can review notes and tick boxes to include desired companion crops into specific polyculture.

In the next, 3 parts you can enhance specific functions with extra spice and aromatic crops: such as pest control, attracting pest predators, and weed controls. The structure is similar: you should first select pests, biocontrol organisms or weeds of particular concern. Section on pest lists pests of selected crops where reports on spice and aromatic crops for controlling these pests are available. Each section contains the link to notes. Our algorithm is not always capable to retrieve notes – than you can follow the link to see complete literature review and manually search reports on specific pest of weed species in a respective sheet or column (you can drag and resize formula box to

conveniently display the whole note or just copy-paste a note into external document). After listing all pests or weeds of concern, press "Prefill dropdown list" button to retrieve the list of spice and aromatic crops in each section. Again, this is again dropdown list, where you can include any extra spice and aromatic crop based on your survey of literature review sheet. Then, similarly to previous sections, you need to tick boxes for desired spice and aromatic crops next to a polyculture where you want to include these crops.

The final sections allow you to review and exclude any crops which are reported as incompatible to your recently included polyculture components. Incompatible crops are excluded from your polycultures by default, and you need to select them from dropdown displayed list next to each polyculture if you want to keep them based on your knowledge or experience.

There is a separate tab where you can see crop lists after each step, for your convenience.

SERVICE STEP — UPDATE CALCULATIONS

The next tab is a service tab which is used to update calculations for the next steps based on your inputs in the previous steps. Open this spreadsheet and wait till it completely finishes all calculations indicated by disappearance of green progress bar in a top right corner. This step takes a while depending on processing power of your computer, and green bar will appear and disappear multiple times. When it completely disappears click the link to proceed to step 9

9 - INCOMPABILITY

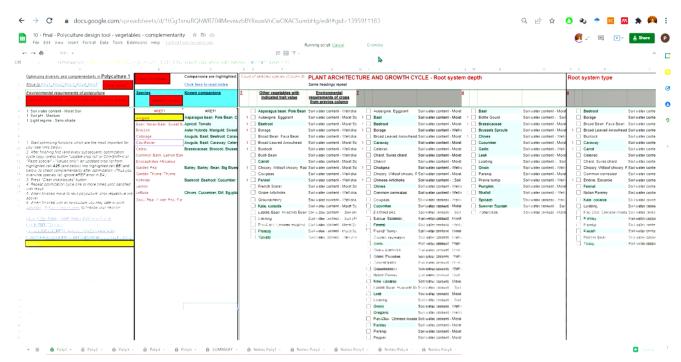The last two steps are time demanding as more calculations are involved. During step 9 you can review if any of the recently added crops are not matching environmental requirements that you defined for your polycultures. First, as always, you need to clear input from a previous user. Then click button "Update crop list" and wait till the script updates spreadsheet data.
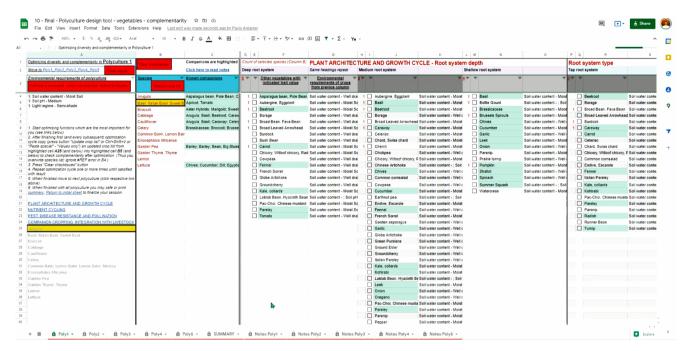
9 - INCOMPABILITY

Spreadsheet displays incompatibilities only for defined environmental criteria. N/A means that information is not available in our database, and you can manually supplement it from dropdown list to improve this tool for the subsequent users. As well as you can correct any false information on environmental requirements. If any crops are defined as incompatible by one or several environmental criteria (which also includes N/A boxes) you need to manually tick all checkboxes in the rows for those crops which you want to keep in your polycultures. There are 5 sheets for separate polycultures, if you are designing several at time. After reviewing information for all your polycultures proceed to the final step.

10 - COMPLEMENTARITY

In the last step you can increase complementarity of resource use in your polycultures.
Start from pressing "Clear inputs" and wait till crop list will reset and update.

10 - COMPLEMENTARITY

There are 5 different tabs for optimizing complementarity in each polyculture. Crop list is red, and companions of selected crops highlighted green. Red numbers relate to crop list in red and indicate the number of crops possessing a particular traits. 3 columns to the right from each column containing numbers list other crops from our database which have indicated trait value. To improve resource use efficiency the main strategy is to optimize trait diversity within the polyculture, such us root depth and nutrient assimilation capacities. However, for some traits, such as association with mycorrhizal fungi and fungal-bacterial ratio, you would rather want to increase similarity between your polyculture components. Right column next to each crop column lists crop environmental requirements, namely those criteria which you earlier indicated for your polycultures. You can press button to visualize environmental criteria for the crops of interest in a pop-up window.

You shall optimize complementarity step-by-step by selecting functions in order of importance that you define for yourself. Click one of 4 categories listed in the first column: (1) plant architecture, (2) nutrient cycling, (3) pest resistance or (4) companion cropping and integration with livestock. If you have few crop under any category in a group, you may want to increase the number of crops in this category. Try prioritizing crops highlighted green which are the companions of previously selected crops, review if environmental requirements of newly added crops are compatible with your conditions, and tick boxes next to desired crops.

Updated crop list is displayed in gray at the bottom of the first column. After finishing with optimizing each function copy this updated crop list to the cell B5. You can do this either manually or by pressing the button "Update crop list". After this step you need to remove all checkboxes to continue with subsequent optimization cycle. Again, you can do this either manually or by pressing button "Clear checkboxes". Wait till spreadsheet update companion list (which may take a while) and continue with optimization of another trait group until you satisfied with the result.

Each time you add new crops you get new profile of trait distribution for all traits in a given polyculture. Process of optimizing crop complementarity requires a lot of time and computations. Therefore, we suggest to focus only on those traits which are the most important for you for each polyculture.
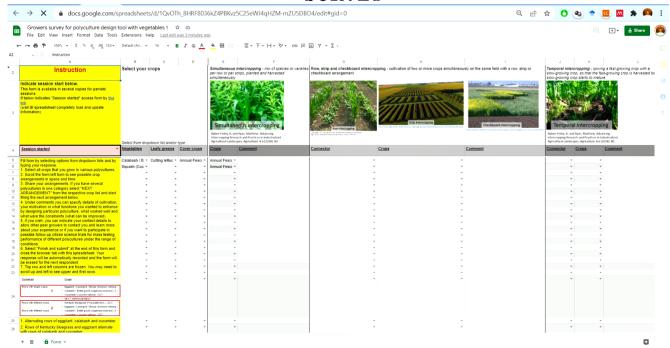
At the end or after each step you can review known incompatible crops – they are listed at the end of each sheet. Incompatible crops are excluded by default unless you tick checkbox to keep it in your polyculture.

At the end of optimization process for each polyculture or at any time you can click link to read detailed notes on selected crops. Namely, information about companions and incompatibles, cultivation, uses, and concerns.

After you finished trait optimization with all your polycultures you may click link to open summary in a new sheet. You can print resulting crop lists or save it in a pdf format.

At the end of you work with the tool you need to follow the link to return to the first spreadsheet and to finish your session by selecting respective option from the dropdown list.

SURVEY

We would appreciate if you share your experience with crop polycultures for improving this tool. Open survey by clicking link which is available on the Summary page or on the first page of design spreadsheet. Wait till this spreadsheet opens and resets data from a previous respondent. Select "Start survey" from a dropdown list in the fist column. Select you crops from dropdown lists or type if not available. Report all polyculture arrangements in space and time for your crops. "Next arrangement" choice is available in all crop lists to report and separate several crop arrangements of a particular type. Connectors are available to specify details of crop arrangements, and comment field is present for any extra notes. Indicate your country, your willingness to be contacted by other growers who may want to learn more about your experience, as well as your willingness to participate in a citizen science trials to test performance of crop polycultures with your peer growers under different environmental conditions. Finally, select "Finish and submit" and close this spreadsheet to record your responses.

We hope that this tool will help you to make informed decisions on designing your polycultures. And we would be happy for your help on improving this tool as well as on developing polyculture recommendations for other growers!