

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



zalf Leibniz Centre for Agricultural Landscape Research (ZALF)

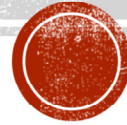
Solidarische Landwirtschaft
sich die Ernte teilen

POLY CULTURE DESIGN TOOL
VEGETABLES AND LEAFY GREENS

Succow Stiftung

Pavlo Ardanov

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RÍO NEGRO
UNIVERSIDAD NACIONAL



Instituto de Investigaciones en
Recursos Naturales,
Agroecología y Desarrollo Rural
IRNAD

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

1 Polyculture design tool - vegetables - initial

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Instruction		Known companions for selected crops		Your final design shall not necessary include all ticked options	Continue to crop environmental requirements
<p>Send feedback to pavlo.ardanov@iamail.com</p> <p>Beta-version of polyculture design tool for vegetables, leafy greens, and spice and aromatic plants</p> <p>Check session status here before start</p>		<p>Click here to read more about companions and incompatible crops</p> <p>Crops available in databases</p>		<p>Select companions to consider for your polycultures</p>	<p>Shortcut: skip to zonal crop arrangement (without reviewing and correcting possible miscellaneous data)</p>
Choose desired cash crops		Companion crops	Number of associations	Associated cash crops	
4	This tool allows you to design polycultures for better productivity, more efficient resource use and for natural pest control. Here we refer "polycultures" to all possible means of crop combinations in space and time (see this link). Thus you can design intercropping, crop rotations, and combinations of these two. Note that the majority of facilitative crop interactions (improved resource use and nutrient cycling, biological pest control) require direct crop contact. Generally your goal is to diversify above-and below ground crop traits across space and time while eliminating incompatibilities. This depend on both crop selection and the mean of their combination .	Arugula	Marigold	6 Aubergine, Eggplant, Carrot, Cabbage, Dill, Parsnip, Pumpkin	<input type="checkbox"/>
5		Aubergine, Eggplant	Radish	4 Onion, Carrot, Pumpkin, Cucumber	<input type="checkbox"/>
6		Onion	Tomato	4 Onion, Carrot, Cabbage, Cucumber	<input checked="" type="checkbox"/>
7		Bean	Bean	4 Arugula, Aubergine, Eggplant, Dill, Parsnip, Pumpkin	<input type="checkbox"/>
8		Parsonip	Onion	3 Arugula, Carrot, Cabbage	<input type="checkbox"/>
9		Carrot	Dill	3 Aubergine, Eggplant, Cabbage, Cucumber	<input type="checkbox"/>
10		Cabbage	Rosemary	3 Aubergine, Eggplant, Carrot, Cabbage	<input type="checkbox"/>
11		Pumpkin	Sage	3 Aubergine, Eggplant, Carrot, Cucumber	<input type="checkbox"/>
12		Broccoli	Sweet Marjoram	3 Aubergine, Eggplant, Onion, Cucumber	<input type="checkbox"/>
13	Performance of polycultures is context-specific. Please, test performance of species assemblages on a small scale first.	Cucumber	Mustard	3 Onion, Cabbage, Cucumber	<input type="checkbox"/>
14	The tool combines 3 approaches:		Lettuce	3 Carrot, Cabbage, Cucumber	<input type="checkbox"/>
15	- Trait-based approach utilizing information from 3 databases: Plants for a Future (PFAF) , National Plant Digital Database (NPDC) , and TRY database . You can improve this tool by supplementing missing information and by correcting outputs whenever databases report incompatible crops .		Asparagus bean, Pole Bean	2 Arugula, Aubergine, Eggplant	<input type="checkbox"/>
16			Carrot	2 Arugula, Onion	<input type="checkbox"/>
17			Garden Pea	2 Arugula, Carrot	<input type="checkbox"/>
18			Arugula	2 Aubergine, Eggplant, Cabbage	<input type="checkbox"/>
19			Basil	2 Aubergine, Eggplant, Cabbage	<input type="checkbox"/>
20			Caraway	2 Aubergine, Eggplant, Cabbage	<input type="checkbox"/>

Master sheet | Companions and incompatibles

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

1 - INITIAL

1 Polyculture design tool - vegetables - initial

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Instruction	Choose desired cash crops	Known companions for selected crops	Your final design shall not necessary include all boxed options	Continue to crop environmental requirements
Send feedback to pavlo.ardanov@gmail.com	Clear inputs	Crops available in databases	Select companions to consider for your polyculture	Shortcut: skip to zonal crop arrangement (without reviewing and correcting possible miscellaneous data)
Send feedback to pavlo.ardanov@gmail.com	Choose desired cash crops	Companion crops	Number of associations	Associated cash crops
4 Indicate start and end of your session below	Arugula	Marigold	6 Aubergine, Eggplant, Carrot, Pumpkin, Broccoli, Broomrape	<input type="checkbox"/>
5 Session finished	Aubergine, Eggplant	Radish	4 Onion, Carrot, Pumpkin, Broccoli	<input type="checkbox"/>
6 If current session is not finished by previous user	Onion	Tomato	4 Onion, Carrot, Cabbage, Pumpkin, Broccoli	<input checked="" type="checkbox"/>
7 -Go to link 2	Bean	Bean	4 Arugula, Aubergine, Eggplant, Pumpkin, Broccoli	<input type="checkbox"/>
8 -Go to link 3	Parsnip	Onion	3 Arugula, Carrot, Cabbage, Pumpkin, Broccoli	<input type="checkbox"/>
9 -Go to link 4	Carrot	Dill	3 Aubergine, Eggplant, Cabbage, Pumpkin, Broccoli	<input type="checkbox"/>
10 -Go to link 5	Cabbage	Rosemary	3 Aubergine, Eggplant, Carrot, Pumpkin, Broccoli	<input type="checkbox"/>
11 Click to share your experience with other users of this tool	Pumpkin	Sage	3 Aubergine, Eggplant, Carrot, Pumpkin, Broccoli	<input type="checkbox"/>
12	Broccoli	Sweet Marjoram	3 Aubergine, Eggplant, Onion, Pumpkin, Broccoli	<input type="checkbox"/>
13 The tool combines 3 approaches:	Cucumber	Mustard	3 Onion, Cabbage, Cucumber, Pumpkin, Broccoli	<input type="checkbox"/>
14 - Trait-based approach utilizing information from 3 databases: Plants for a Future (PFAP), Natural Plant Culture Database (NPC), and The Database. You can improve this tool by supplementing missing information and by correcting outputs whenever databases report different values		Lettuce	3 Carrot, Cabbage, Cucumber, Pumpkin, Broccoli	<input type="checkbox"/>
15 - Citizen science approach - you can utilize suggestions from peer growers as well as to share your own experience		Asparagus bean, Pole Bean	2 Arugula, Aubergine, Eggplant, Carrot, Pumpkin, Broccoli	<input type="checkbox"/>
16 - Systematic literature review approach - you can improve performance of your vegetable polycultures by including spice and aromatic crops with proven efficiency in pest control and growth promotion.		Carrot	2 Arugula, Onion, Pumpkin, Broccoli	<input type="checkbox"/>
		Garden Pea	2 Arugula, Carrot, Pumpkin, Broccoli	<input type="checkbox"/>
		Arugula	2 Aubergine, Eggplant, Cabbage, Pumpkin, Broccoli	<input type="checkbox"/>
		Basil	2 Aubergine, Eggplant, Cabbage, Pumpkin, Broccoli	<input type="checkbox"/>
		Caraway	2 Aubergine, Eggplant, Cabbage, Pumpkin, Broccoli	<input type="checkbox"/>
		Coriander, Cilantro	2 Aubergine, Eggplant, Cabbage, Pumpkin, Broccoli	<input type="checkbox"/>
		English Lavender	2 Aubergine, Eggplant, Cabbage, Pumpkin, Broccoli	<input type="checkbox"/>
		Fennel	2 Aubergine, Eggplant, Cabbage, Pumpkin, Broccoli	<input type="checkbox"/>
		Lavender	2 Aubergine, Eggplant, Cabbage, Pumpkin, Broccoli	<input type="checkbox"/>

Master sheet Companions and incompatibles

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

1 Polyculture design tool - vegetables - initial

File Edit View Insert Format Data Tools Extensions Help Last edit was 5 minutes ago

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Session started

Instruction
 - Send feedback to pavlo.ardanyov@gmail.com
 - Beta version of polyculture design tool for vegetables, leafy greens, and spice and aromatic plants
 - Check system status here before start

Clear inputs
 Choose desired cash crops

Known companions for selected crops
 Click here to read more about companions and incompatible crops
 Crops available in databases

Companion crops	Number of associations	Associated cash crops	Select companions to consider for your polyculture
Marigold	6	Aubergine, Eggplant, Carrot, Pumpkin, Broccoli, Broomrape	<input type="checkbox"/>
Radish	4	Onion, Carrot, Pumpkin, Broomrape	<input type="checkbox"/>
Tomato	4	Onion, Carrot, Cabbage, Pumpkin	<input checked="" type="checkbox"/>
Bean	4	Arugula, Aubergine, Eggplant, Pumpkin	<input type="checkbox"/>
Onion	3	Arugula, Carrot, Cabbage, Pumpkin	<input type="checkbox"/>
Dill	3	Aubergine, Eggplant, Cabbage, Pumpkin	<input type="checkbox"/>
Rosemary	3	Aubergine, Eggplant, Carrot, Pumpkin	<input type="checkbox"/>
Sage	3	Aubergine, Eggplant, Carrot, Pumpkin	<input type="checkbox"/>
Sweet Marjoram	3	Aubergine, Eggplant, Onion, Pumpkin	<input type="checkbox"/>
Mustard	3	Onion, Cabbage, Cucumber, Pumpkin	<input type="checkbox"/>
Lettuce	3	Carrot, Cabbage, Cucumber, Pumpkin	<input type="checkbox"/>
Asparagus bean, Pole Bean	2	Arugula, Aubergine, Eggplant, Pumpkin	<input type="checkbox"/>
Carrot	2	Arugula, Onion, Pumpkin	<input type="checkbox"/>
Garden Pea	2	Arugula, Carrot, Pumpkin	<input type="checkbox"/>
Arugula	2	Aubergine, Eggplant, Cabbage, Pumpkin	<input type="checkbox"/>
Basil	2	Aubergine, Eggplant, Cabbage, Pumpkin	<input type="checkbox"/>
Caraway	2	Aubergine, Eggplant, Cabbage, Pumpkin	<input type="checkbox"/>
Coriander, Cilantro	2	Aubergine, Eggplant, Cabbage, Pumpkin	<input type="checkbox"/>
English Lavender	2	Aubergine, Eggplant, Cabbage, Pumpkin	<input type="checkbox"/>
Fennel	2	Aubergine, Eggplant, Cabbage, Pumpkin	<input type="checkbox"/>
Lavender	2	Aubergine, Eggplant, Cabbage, Pumpkin	<input type="checkbox"/>

Your final design shall not necessary include all ticked options

Continue to crop environmental requirements
 Shortcut: skip to zonal crop arrangement (without reviewing and correcting possible miscellaneous data)

Any errors on this sheet?

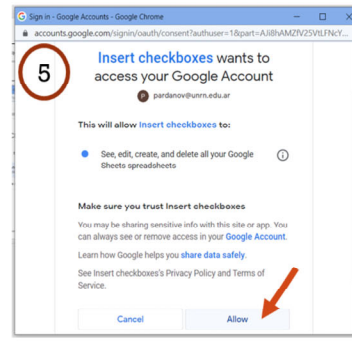
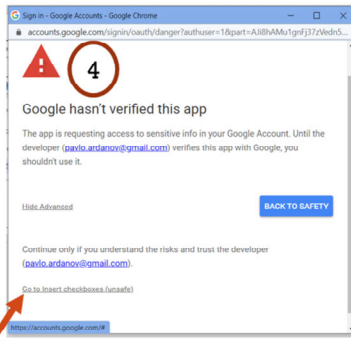
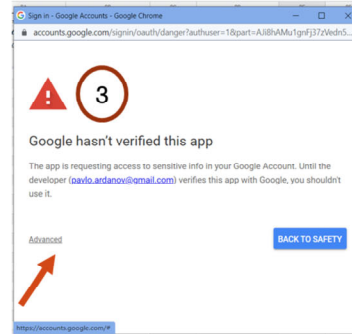
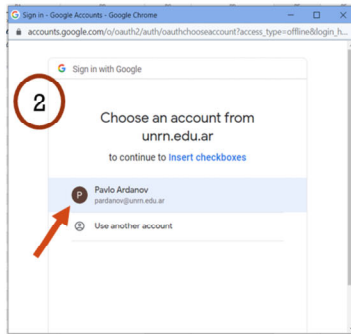
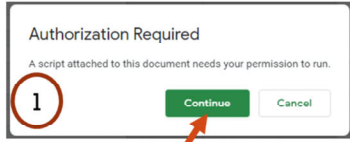
4 Indicate start and end of your session below
 5 Session started
 6 If current session is not finished by previous user
 7 - Go to link 2
 8 - Go to link 3
 9 - Go to link 4
 10 - Go to link 5
 11 Click to share your experience with other users of this tool.
 12 The tool combines 3 approaches:
 - Trait-based approach utilizing information from 3 databases: [Plants for a Future \(PPAF\)](#), [Natural Plant-Crop Database \(NPC\)](#) and [The Database](#). You can improve this tool by supplementing missing information and by correcting outputs whenever databases report different values.
 - Citizen science approach - you can utilize suggestions from peer growers as well as to share your own experience.
 - Systematic literature review approach - you can improve performance of your vegetable polycultures by including spice and aromatic crops with proven efficiency in pest control and growth promotion.

Arugula
 Aubergine, Eggplant
 Onion
 Bean
 Parsnip
 Carrot
 Cabbage
 Pumpkin
 Broccoli
 Cucumber

Master sheet
 Companions and incompatibles

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

SCRIPT AUTHORIZATION



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

1 - INITIAL

1 Polyculture design tool - vegetables - initial

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1 Instruction

2 Send feedback to pavlo.ardanov@gmail.com

3 Beta-version of polyculture design tool for vegetables, leafy greens, and spice and aromatic plants

4 Select session status here before start

45 account (click round button "Google account" in the right corner). When clicking a button for the first time you will see a pop-up window "Authorization required" - You need to authorize "Scripts" - press "Google hasn't verified this app" - "Advanced" - "Go to Scripts (unsafe)" - "Allow". Then you can press a button again to perform required action.

51 Most workbooks require pressing action buttons to load data (and some additionally require opening of service spreadsheets). Follow instructions at the beginning of each workbook.

55 - Green running bar at the top right corner of each workbook indicates the progress of computations (and the green bar disappears) before moving to the next workbook. Workbooks utilize your computer's operational power. Some calculations might be lengthy depending on a workbook and your computer's capacity.

61 - Each spreadsheet contains design sheets (up to 5) and sheets with notes. You can simultaneously open different sheets of a workbook in different tabs or browser windows to visualize information side-by-side.

65 - The tool is in text mode and we shall be grateful for your feedback. Please, report to Pavlo Ardanov (pavlo.ardanov@gmail.com) on any errors indicating the name of spreadsheet.

68

Clear crops

Choose desired cash crops

Known companions for selected crops

Crops available in databases

Companion crops

Number of associations

Associated cash crops

Your final design shall not necessary include all boxed options

Select companions to consider for your polycultures

Continue to crop environmental requirements

Shortcut: skip to zonal crop arrangement (without reviewing and correcting possible miscellaneous data)

Master sheet

Companions and incompatibles

Explore

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 bar companions by their environmental requirements, so at this point you can select whole range of desired crops irrespective of their cultivation requirements.

1 - INITIAL

docs.google.com/spreadsheets/d/1Jz568FWbju8p0K-e-V5-6UsUjE3YXYdnlDrWyoMFs/edit#gid=312729472

1 Polyculture design tool - vegetables - initial

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1 **Instruction**

2 Send feedback to pavlo.ardany@gmail.com

3 Beta version of polyculture design tool for vegetables, leafy greens, and spice and aromatic plants.

4 Check session status here before start

5 **Clear inputs**

6 Choose desired cash crops

7 **Known companions for selected crops**

8 [Click here to read more about companions and incompatible crops](#)

9 Crops available in database

10 Companion crops

11 Number of associations

12 Associated cash crops

13 Your final design shall not necessary include all ticked options

14 Select companions to consider for your polyculture

15 Continue to skip environmental requirements

16 [Shortcut: skip to zonal crop arrangement](#) (without re-saving and correcting possible miscellaneous data)

17 **Any errors on this sheet?**

18 Indicate start and end of your session below

19 Session started

20 If current session is not finished by previous user

21 - Go to link 2

22 - Go to link 3

23 - Go to link 4

24 - Go to link 5

25 Click to share your experience with other users of this tool

26 The tool combines 3 approaches:

27 Trait-based approach utilizing information from 3 databases: [Plants for a Future \(PFAP\)](#), [Natural Plant Capital Database \(NPC\)](#), and [TRY Database](#). You can improve this tool by supplementing missing information and by correcting outputs whenever databases report different values.

28 Citizen science approach - you can utilize suggestions from peer growers as well as to share your own experience.

29 Systematic literature review approach - you can improve performance of your vegetable polycultures by including spice and aromatic crops with proven efficiency in pest control and growth promotion.

Companion crops	Number of associations	Associated cash crops	Select companions to consider for your polyculture
Onion	2	Arugula, Celery	<input type="checkbox"/>
Tomato	2	Basil, Celery	<input type="checkbox"/>
Asparagus bean, Pole Bean	1	Arugula	<input type="checkbox"/>
Carrot	1	Arugula	<input type="checkbox"/>
Garden Pea	1	Arugula	<input type="checkbox"/>
Apricot	1	Basil	<input type="checkbox"/>
Brassicaceae	1	Celery	<input type="checkbox"/>
Broccoli	1	Celery	<input type="checkbox"/>
Brussels Sprouts	1	Celery	<input type="checkbox"/>
Cabbage	1	Celery	<input type="checkbox"/>
Cauliflower	1	Celery	<input type="checkbox"/>
Chives	1	Celery	<input type="checkbox"/>
Cosmos	1	Celery	<input type="checkbox"/>
Egyptian Onion, Walking Onion, Top onion, Tree Onion	1	Celery	<input type="checkbox"/>
French Bean, Kidney bean	1	Celery	<input type="checkbox"/>
Garden Nasturtium	1	Celery	<input type="checkbox"/>
Garlic	1	Celery	<input type="checkbox"/>
Garlic Chives	1	Celery	<input type="checkbox"/>
Kale, collards	1	Celery	<input type="checkbox"/>
Kohlrabi	1	Celery	<input type="checkbox"/>

Master sheet | Companions and incompatibles

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.

1 - INITIAL

The screenshot shows a Google Sheet interface with the following content:

Instruction		Choose desired cash crops		Known companions for selected crops			Your final design shall not necessary include all ticked options
Beta-version of polyculture design tool for vegetables, leafy greens, and spice and aromatic plants		Celery		Companion crops	Number of associations	Associated cash crops	Select companions to consider for your polycultures
Arugula	Onion	2	Arugula, Celery	<input checked="" type="checkbox"/>			
Basil	Tomato	2	Basil, Celery	<input checked="" type="checkbox"/>			
Bean	Asparagus bean, Pole Bean	1	Arugula	<input type="checkbox"/>			
Celery	Carrot	1	Arugula	<input type="checkbox"/>			
	Garden Pea	1	Arugula	<input checked="" type="checkbox"/>			
	Apricot	1	Basil	<input type="checkbox"/>			
	Brassicaceae	1	Celery	<input type="checkbox"/>			
	Broccoli	1	Celery	<input checked="" type="checkbox"/>			
	Brussels Sprouts	1	Celery	<input type="checkbox"/>			
	Cabbage	1	Celery	<input type="checkbox"/>			
	Cauliflower	1	Celery	<input type="checkbox"/>			
	Chives	1	Celery	<input type="checkbox"/>			
	Cosmos	1	Celery	<input type="checkbox"/>			
	Egyptian Onion, Walking Onion, Top onion, Tree Onion	1	Celery	<input type="checkbox"/>			
	French Bean, Kidney bean	1	Celery	<input type="checkbox"/>			
	Garden Nasturtium	1	Celery	<input type="checkbox"/>			
	Garlic	1	Celery	<input type="checkbox"/>			
	Garlic Chives	1	Celery	<input type="checkbox"/>			
	Kale, collards	1	Celery	<input type="checkbox"/>			
	Kohlrabi	1	Celery	<input type="checkbox"/>			

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

The image displays two side-by-side screenshots of a Google Sheets spreadsheet titled "1 Polyculture design tool - vegetables - initial".

Left Screenshot (Main Design Sheet):

- Row 1:** Instruction: "Send feedback to pavlo.ardanov@gmail.com"
- Row 2:** Instruction: "Beta-version of polyculture design tool for vegetables, leafy greens, and spice and aromatic plants." A red button labeled "Clear inputs" is visible.
- Row 3:** Instruction: "Check session status here before start"
- Row 4:** Instruction: "Indicate start and end of your session below:"
- Row 5:** Instruction: "Session started" - A dropdown menu shows "Basil".
- Row 6:** Instruction: "If current session is not finished by previous user:" - A dropdown menu shows "Bean".
- Row 7:** Instruction: "- Go to link 2" - A dropdown menu shows "Celery".
- Row 8:** Instruction: "- Go to link 3" - A dropdown menu shows "Garden Pea".
- Row 9:** Instruction: "- Go to link 4" - A dropdown menu shows "Apricot".
- Row 10:** Instruction: "- Go to link 5" - A dropdown menu shows "Brassicaceae".
- Row 11:** Instruction: "Click to share your experience with other users of this tool." - A dropdown menu shows "Broccoli".
- Row 12:** Instruction: "The tool combines 3 approaches:" - A dropdown menu shows "Brussels Sprouts".
- Row 13:** Instruction: "- Trail-based approach utilizing information from 3 databases: [Plant for a Future \(PFAF\)](#), [National Plant Catalog Database \(NPC\)](#), and [ITV database](#). You can improve this tool by supplementing missing information and by correcting outputs whenever databases report different values." - A dropdown menu shows "Cabbage".
- Row 14:** Instruction: "- Citizen science approach - you can utilize suggestions from peer growers as well as to share your own experience." - A dropdown menu shows "Cauliflower".
- Row 15:** Instruction: "- Systematic literature review approach - you can improve performance of your vegetable polycultures by including spice and aromatic crops with proven efficiency in pest control and growth promotion." - A dropdown menu shows "Chives".
- Row 16:** Instruction: "- Systematic literature review approach - you can improve performance of your vegetable polycultures by including spice and aromatic crops with proven efficiency in pest control and growth promotion." - A dropdown menu shows "Cosmos".
- Row 17:** Instruction: "- Systematic literature review approach - you can improve performance of your vegetable polycultures by including spice and aromatic crops with proven efficiency in pest control and growth promotion." - A dropdown menu shows "Egyptian Onion, Walking Onion, Top onion, Tree Onion".
- Row 18:** Instruction: "- Systematic literature review approach - you can improve performance of your vegetable polycultures by including spice and aromatic crops with proven efficiency in pest control and growth promotion." - A dropdown menu shows "French Bean, Kidney bean".
- Row 19:** Instruction: "- Systematic literature review approach - you can improve performance of your vegetable polycultures by including spice and aromatic crops with proven efficiency in pest control and growth promotion." - A dropdown menu shows "Garden Nasturtium".
- Row 20:** Instruction: "- Systematic literature review approach - you can improve performance of your vegetable polycultures by including spice and aromatic crops with proven efficiency in pest control and growth promotion." - A dropdown menu shows "Garlic".
- Row 21:** Instruction: "- Systematic literature review approach - you can improve performance of your vegetable polycultures by including spice and aromatic crops with proven efficiency in pest control and growth promotion." - A dropdown menu shows "Garlic Chives".
- Row 22:** Instruction: "- Systematic literature review approach - you can improve performance of your vegetable polycultures by including spice and aromatic crops with proven efficiency in pest control and growth promotion." - A dropdown menu shows "Kale, collards".
- Row 23:** Instruction: "- Systematic literature review approach - you can improve performance of your vegetable polycultures by including spice and aromatic crops with proven efficiency in pest control and growth promotion." - A dropdown menu shows "Kohlrabi".

Table: Known companions for selected crops

Crops available in databases	Companion crops	Number of associations	Associated
Onion		2	Arugula, Celery
Tomato		2	Basil, Celery
Asparagus bean, Pole Bean		1	Arugula
Carrot		1	Arugula
Garden Pea		1	Arugula
Apricot		1	Basil
Brassicaceae		1	Celery
Broccoli		1	Celery
Brussels Sprouts		1	Celery
Cabbage		1	Celery
Cauliflower		1	Celery
Chives		1	Celery
Cosmos		1	Celery
Egyptian Onion, Walking Onion, Top onion, Tree Onion		1	Celery
French Bean, Kidney bean		1	Celery
Garden Nasturtium		1	Celery
Garlic		1	Celery
Garlic Chives		1	Celery
Kale, collards		1	Celery
Kohlrabi		1	Celery

Right Screenshot (RETURN TO MAIN SHEET):

Table: Known companions

Known incompatible crops	Desired cash crops	Known companions	Notes
Arugula	Arugula	Asparagus bean, Pole Bean, Carrot, Garden Pea, Onion	
Basil	Basil	Apricot, Tomato	* Tomato * Tradition suggests basil enhar
Bean	Bean		
Celery	Celery	Brassicaceae, Broccoli, Brussels Sprouts, Cabbage, Cauliflower, Chives, Cosmos, Egyptian Onion, Walking Onion, Top onion, Tree Onion, French Bean, Kidney bean, Garden Nasturtium, Garlic, Garlic Chives, Kale, collards, Kale, collards, Kohlrabi, Leek, Leek, Mustard, Mustard Green, Onion, Ornamental Onion, Pale Purple Coneflower, Prairie Onion, Radish, Rapeseed, Shallot, Spinach, Tomato, Tomato, Turnip, Welsh Onion, Zinnia	* Brassicaceae * A good companion for le cabbage while butterfly so is a good comp * French Bean, Kidney bean * A good com * Leek * Leeks repel carrot fly from celery * Spinach * Compiled from traditional liter * Tomato * Tradition suggests celery grow * Tomato * A good companion for leeks, t

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

1 - INITIAL

The screenshot shows a Google Sheets spreadsheet with the following structure:

- Row 1:** Instruction: Send feedback to eric@aridcitylab.com
- Row 2:** Instruction: Beta-version of polyculture design tool for vegetables, leafy greens, and spice and aromatic plants. Includes a "Clear inputs" button.
- Row 3:** Instruction: Check session status here before start.
- Row 4:** Instruction: Indicate start and end of your session below. Includes a dropdown menu with "Arugula" selected.
- Row 5:** Instruction: Session started. Includes a dropdown menu with "Basil" selected.
- Row 6:** Instruction: If current session is not finished by previous user. Includes a dropdown menu with "Bean" selected.
- Row 7:** Instruction: - Go to link 2. Includes a dropdown menu with "Celery" selected.
- Row 8:** Instruction: - Go to link 3.
- Row 9:** Instruction: - Go to link 4.
- Row 10:** Instruction: - Go to link 5.
- Row 11:** Instruction: Click to share your experience with other users of this tool.
- Row 12:** Instruction: The tool combines 3 approaches: Trait-based approach utilizing information from 3 databases: Plants for a Future (PFAF), Natural Plant Capital Database (NPC), and TRY database. You can improve this tool by supplementing missing information and by correcting outputs whenever databases report different values.
- Row 13:** Instruction: Citizen science approach - you can utilize suggestions from peer growers as well as to share your own experience.
- Row 14:** Instruction: Systematic literature review approach - you can improve performance of your vegetable polycultures by including spice and aromatic crops with proven efficiency in pest control and growth promotion.
- Row 15:** Instruction: Known companions for selected crops. Click here to read more about companions and incompatible crops.
- Row 16:** Instruction: Crops available in databases.
- Row 17:** Instruction: Companion crops. Includes a table with columns: Companion crops, Number of associations, Associated cash crops, and Select companions to consider for your polycultures.
- Row 18:** Instruction: Your final design shall not necessary include all listed options.
- Row 19:** Instruction: Continue to crop environmental requirements. Includes a link: Shortcut skip to zonal crop arrangement (without reviewing and correcting possible miscellaneous data).
- Row 20:** Instruction: Any errors on this sheet? (Yellow field)
- Row 21:** Instruction: Onion (2 Arugula, Celery)
- Row 22:** Instruction: Tomato (2 Basil, Celery)
- Row 23:** Instruction: Asparagus bean, Pole Bean (1 Arugula)
- Row 24:** Instruction: Carrot (1 Arugula)
- Row 25:** Instruction: Garden Pea (1 Arugula)
- Row 26:** Instruction: Apricot (1 Basil)
- Row 27:** Instruction: Brassicaceae (1 Celery)
- Row 28:** Instruction: Broccoli (1 Celery)
- Row 29:** Instruction: Brussels Sprouts (1 Celery)
- Row 30:** Instruction: Cabbage (1 Celery)
- Row 31:** Instruction: Cauliflower (1 Celery)
- Row 32:** Instruction: Chives (1 Celery)
- Row 33:** Instruction: Cosmos (1 Celery)
- Row 34:** Instruction: Egyptian Onion, Walking Onion, Top onion, Tree Onion (1 Celery)
- Row 35:** Instruction: French Bean, Kidney bean (1 Celery)
- Row 36:** Instruction: Garden Nasturtium (1 Celery)
- Row 37:** Instruction: Garlic (1 Celery)
- Row 38:** Instruction: Garlic Chives (1 Celery)
- Row 39:** Instruction: Kale, collards (1 Celery)
- Row 40:** Instruction: Kohlrabi (1 Celery)

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

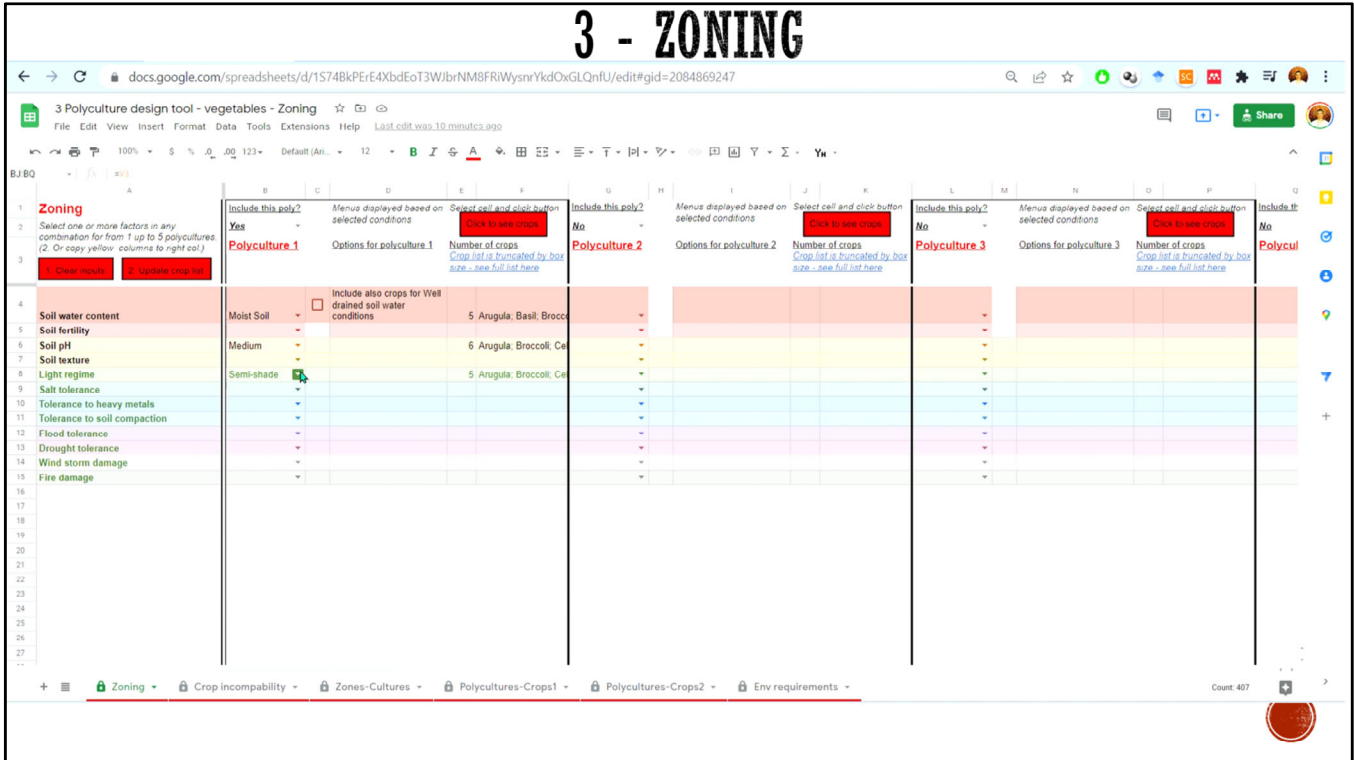
From this first design spreadsheet you can continue to the next spreadsheet to review and if necessary correct crop environmental requirements or skip to the next step and proceed to zonal crop arrangement. Or you simply learn about known companions and finish using tool at this point (don't forget to finalize your session 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

1	Water requirements										Nutrient requirements				
2	Water requirements (PPAF database)		Soil moisture requirements (NPC database)			Species environmental indicator value according to Ellenberg: moisture (TRY database)					Soil fertility (PPAF database)				
3	Moist Soil	Well drained soil	Wet	Moderate	Dry	High	Medium	Low	Moisture requirements, miscellaneous	Select right option, in your opinion	Moisture requirements, data not available	Select right options, in your opinion	Highly fertile soils	Moderately fertile soils	Low fertile
4	Arugula	Arugula	Runner Bean	Arugula	Arugula	Celery		Broad Bean, Fava Bean	Arugula	Well drained soil	Bean		Basil		
5	Basil			Asparagus bean, Pole Bean	Asparagus bean, Pole Bean			Onion	Broad Bean, Fava Bean	Well drained soil			Broccoli		
6	Broad Bean, Fava Bean			Basil	Bush Bean			Onion	Well drained soil				Garden Pea		
7	Broccoli			Broad Bean, Fava Bean	Runner Bean			Runner Bean	Well drained soil				Onion		
8	Celery			Broccoli	Tomato			Tomato	Well drained soil				Runner Bean		
9	French Bean, Kidney bean, Garden Pea			Rush Bean									Tomato		
10	Onion			Garden Pea											
11	Runner Bean			Garden Pea											
12	Tomato			Lablab Bean, Hyacinth Bean											
13				Onion											
14				Runner Bean											
15				Tomato											
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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

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

1	Root type and depth		Long Rhizome		Short Rhizome		Minimum Root Depth - NPC database			Root rooting depth - TRY database			Plant morphological adaptations: root metamorphoses - TRY database		Soil Cultivator - NPC	
2	Root Type - NPC database		Long Rhizome		Short Rhizome		Minimum Root Depth - NPC database			Root rooting depth - TRY database			Plant morphological adaptations: root metamorphoses - TRY database		Soil Cultivator - NPC	
3	Tap	Fibrous Deep	Fibrous Shallow	Long Rhizome	Short Rhizome	Bulb, Tuber or undefined Rhizome	Deep	Medium	Shallow	Deep	Medium	Shallow	Storage root	Root shoot	Strong tap root	Soil
4	Broccoli	Garden Pea	Arugula		Arugula	Arugula		Broccoli	Arugula				Celery		Garden Pea	Very
5	Celery															
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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

Nitrogen fixation		Nitrogen Fixer - DPAF database		Nitrogen accumulation			Leaf nitrogen (N) content per leaf dry mass - TRY database			Root nil
Nitrogen Fixer	Select cell and click button	Nitrogen Fixer	Plant nitrogen(N) fixation capacity - TRY database	Shoot nitrogen (N) content per shoot dry mass - TRY database	Medium	Low	High	Medium	Low	High
Garden Pea	Excellent nitrogen source; stems provide a quick		Yes	High	Medium	Low	High	Medium	Low	High

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

Susceptibility to pests and disease			Disease Issues - NPC database			Insect/Pest Damage - NPC database			Leaf palatability - TRY database		Plant palatability - TRY database		Animal Damage - NPC database		Insecticidal properties	
Minor	Medium	Major	Minor	Medium	Major	Low	Medium	High	Nona	High						
Clear inputs																
Arugula	Garden Pea		Arugula	Broccoli							Garden Pea	Deer			Arugula	Like other mustards, arugula is insecticidal
Broccoli			Celery	Garden Pea											Broccoli	An extract of the seeds inactivates the bacte
Celery															Celery	The growing plant is an insect repellent. It re

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

1	Weed potential			Origin	Habitats - PFAF database		Native to North America? - N
2	Weed Potential - PFAF database			PFAF database: Found In	Range - PFAF database		
3	Yes	No	Invasive		Select cell and click button		Yes
4				Arugula	Waste ground, fields, olive groves, Europe - Mediterranean. A frequent casual in Britain, occasionally becoming esta		
5				Broccoli	Not known in the wild. A cultivated form of B. oleracea.		
6				Celery	Not known in the wild. A cultivated form of garden origin.		
7				Garden Pea	Plants are not known in a genuine E. Asia.		
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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

Companion crops	Number of associations	Associated cash crops (polycultures they belong to)
Cabbage	1	Broccoli (1)
Cauliflower	1	Broccoli (1)
Lettuce	1	Broccoli (1)

You can complement your polycultures with crops compatible to those crops that you 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.

8 — SPICE AND AROMATIC CROPS

The screenshot shows a Google Sheet with the following structure:

- Row 1:** Title "8 — SPICE AND AROMATIC CROPS".
- Row 2:** "Companions reported by survey participants" with a link to read about possible crop integrations.
- Row 3:** "Environmental requirements of polyculture" with a link to read about possible crop integrations.
- Row 4:** "Companion crops" with columns for "Number of associations", "Associated cash crops (polyculture they belong to)", and five "Poly" columns (Poly1 to Poly5) with checkboxes.
- Row 5:** "Companion spices/vegetables" with columns for "Crops selected so far" and "Polyculture they belong to".

Data from the table:

Companion crops	Number of associations	Associated cash crops (polyculture they belong to)	Poly1	Poly2	Poly3	Poly4	Poly5	Crops selected so far	Polyculture they belong to
Cabbage	1	Broccoli (1)	<input checked="" type="checkbox"/>					Arugula	1
Caiflower	1	Broccoli (1)	<input checked="" type="checkbox"/>					Broccoli	1
Lettuce	1	Broccoli (1)	<input checked="" type="checkbox"/>					Cabbage	1
		Garden Pea						Caiflower	1
								Celery	1
								Garden Pea	1
								Lettuce	1

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

8 Polyculture design tool - vegetables - spices and peers suggestions

File Edit View Insert Format Data Tools Extensions Help

100% 123

Continue to the next step (update calculations)

	Reported incompatible crops, if any	Incompatible that you want to include into the polyculture	Crop	Reported incompatible crops, if any	Incompatible that you want to include into the polyculture	Crop	Reported incompatible crops, if any	Incompatible that you want to include into the polyculture	Crop
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
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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

Based on your experience or extra information you may keep some crops (N/A - information is not available in our databases - you can contribute by selecting proper options from dropdown list)
Check boxes for all crops that you want to keep, despite of different environmental requirements or incompatibility

Environmental requirements of polyculture	Species	Soil water content	Soil fertility	Soil pH	Soil texture	Light regime	Salt tolerance	Tolerance to heavy metals	Tolerance to soil compaction	Ek
1. Soil water content - Moist Soil	(Eriosephalus Africanus) []	-	-	-	-	-	-	-	-	-
1. Soil pH - Medium	Anguria	-	-	-	-	-	-	-	-	-
1. Light regime - Semi shade	Basil Italian Basil Sweet B	-	-	-	-	-	-	-	-	-
	Broccoli	-	-	-	-	-	-	-	-	-
	Cabbage	-	-	-	-	-	-	-	-	-
	Cauliflower	-	-	-	-	-	-	-	-	-
	Celery	-	-	-	-	-	-	-	-	-
	Common Balm Lemon Balm	-	-	-	-	-	-	-	-	-
	Garden Pea	-	-	-	-	-	-	-	-	-
	Garden Thyme Thyme (Th	-	-	-	-	-	-	-	-	-
	Lemon (Citrus Limon) []	-	-	-	-	-	-	-	-	-
	Lettuce	-	-	-	-	-	-	-	-	-

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 - INCOMPATIBILITY

The spreadsheet displays the following table structure:

Environmental requirements of polyculture	Species	Soil water content	Soil fertility	Soil pH	Soil texture	Light regime	Salt tolerance	Tolerance to heavy metals	Tolerance to soil compaction
1. Soil water content - Moist Soil	(Ericophatus Africanus) []	#N/A	<input type="checkbox"/>	#N/A	<input type="checkbox"/>	#N/A	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1. Soil pH - Medium	Anguria	<input type="checkbox"/>	<input type="checkbox"/>	Low	<input type="checkbox"/>	Full sun	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
1. Light regime - Semi-shade	Basil Italian Basil Sweet B	<input type="checkbox"/>	<input type="checkbox"/>	Low	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Broccoli	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Cabbage	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Cauliflower	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Celery	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Common Balm, Lemon Bah	#N/A	<input type="checkbox"/>	#N/A	<input type="checkbox"/>	#N/A	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Garden Pea	#N/A	<input type="checkbox"/>	#N/A	<input type="checkbox"/>	#N/A	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Garden Thyme, Thyme (Th	#N/A	<input type="checkbox"/>	#N/A	<input type="checkbox"/>	#N/A	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Lemon (Citrus Limon) []	#N/A	<input type="checkbox"/>	#N/A	<input type="checkbox"/>	#N/A	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
	Lettuce	Well drained soil	<input type="checkbox"/>	Low	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

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

The screenshot shows a complex web application for polyculture design. It features a top navigation bar with 'File', 'Edit', 'View', 'Insert', 'Format', 'Data', 'Tools', 'Extensions', and 'Help'. Below this is a toolbar with various icons for editing and viewing. The main content area is a spreadsheet-like table with columns for crop names, their environmental requirements (soil water content, pH, light regime), and their root system types (Deep, Medium, Shallow, Tap). The table is organized into several sections, with the first section being the primary crop list and subsequent sections showing companion crops and their requirements. The interface includes various interactive elements like checkboxes, buttons, and a sidebar with additional options.

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 as 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

The screenshot shows a Google Sheets spreadsheet titled "Growers survey for polyculture design tool with vegetables 1". The spreadsheet is divided into several sections:

- Instruction:** A yellow box containing instructions for using the survey form, including how to select crops and use dropdown menus.
- Select your crops:** A section with dropdown menus for "Vegetables", "Leafy greens", and "Cover crops".
- Simultaneous intercropping:** A section with a photo of a field and a description: "Simultaneous intercropping - mix of species or varieties per row or per strip, planted and harvested".
- Row, strip and checkboard intercropping:** A section with photos of different field layouts and a description: "Row, strip and checkboard intercropping - cultivation of two or more crops simultaneously on the same field with a row, strip or checkboard arrangement".
- Temporal intercropping:** A section with a photo of a field and a description: "Temporal intercropping - sowing a fast-growing crop with a slow-growing crop, so that the fast-growing crop is harvested or removed before the slow-growing crop starts to mature".
- Table:** A table with columns for "Crops", "Comment", and "Connector". It has multiple rows for recording different crop arrangements.

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 first column. Select your 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!