Agroecology Module V2.0
Documentation

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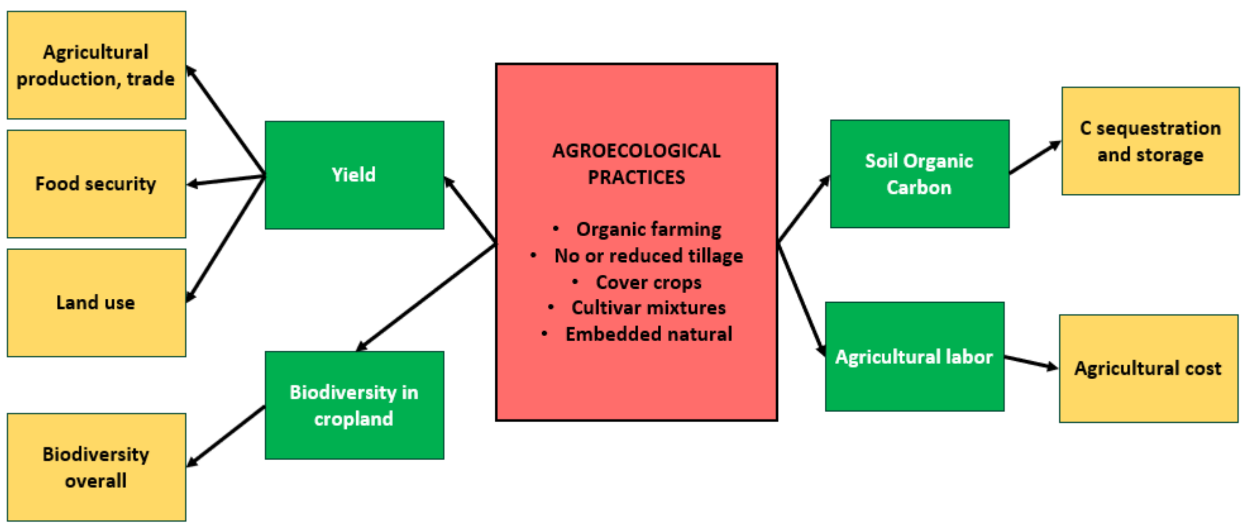
Summary

The agroecology module allows FABLE Calculator users to explore the effects of increasing the coverage of certain agroecological practices on cropland towards 2050. We use *agroecological* as an umbrella term for any practice that is distinct from intensively managed monocultures. Scenarios for the evolution of agroecological practice coverage are defined per commodity group, by country or region. The user can create scenarios that alter the coverage of one or several agroecological practices, and the rate of implementation to 2050. The module estimates the effect of a shift in the area coverage of one agricultural practice to another, using estimates from global meta-analyses. The module currently accounts for estimated effects on yield, biodiversity on cropland, soil organic carbon (SOC) stocks, and production costs through labour (Figure 1).

Figure 1: Overview of the agroecology module



Source: the authors.

Implementing the agroecology module

The agroecology module was released in two parts. A first version was released in April 2023 (UP#36) and allowed users to differentiate agricultural practices and account for their impact on yields and on biodiversity on cropland. A second version was developed and shared in December 2024. It includes the following advancements:

- Adding a biodiversity indicator to assess aggregated changes in biodiversity across all land use classes, per country or region
- Adding SOC stock to the model and accounting for effects of agroecological practices on net GHG emissions, through carbon sequestration and storage in soils
- Linking the agroecology module to the costing module by including effects of practices on labour input

- Debugging identified errors and minor adjustments to improve functioning (including to ensure crops were correctly mapped to the commodity groups used in the model, to remove the risk of practice coverage being erroneously set to lower than the baseline value, and to better account for effects when multiple practices are selected).

Practices included

Agroecology means "applying ecological concepts and principles to optimize interactions between plants, animals, humans and the environment [within agricultural systems] while taking into consideration the social aspects that need to be addressed for a sustainable and fair food system" (FAO 2023). Thirteen agroecological principles have been proposed to operationalize agroecology at the agroecosystem and food system level. Users can choose to increase the coverage of several practices that are broadly consistent with these agroecological principles. The agroecology module version 2.0 includes the following practices:

1. Cover crops: Non-harvested herbaceous crop planted in between harvested crops for agronomic purposes, such as to protect and enrich soils.
2. Cultivar mixtures: At least two cultivars of the same crop species planted simultaneously on the same agricultural land, compared to land used to cultivate a single crop variety.
3. Diversified farming practices: Diversified practices in-field (agroforestry, cultivar mixtures, cover crops, crop rotations, intercropping) compared to monocultures, or embedded natural habitat compared to absence of natural habitat.
4. Embedded natural: On-farm land used for non-productive purposes and where natural or semi-natural vegetation is sown or allowed to naturally regenerate next to productive land or as part of a crop rotation cycle, usually for environmental purposes. It includes hedgerows, flower strips, grass strips, fallow land.
5. Organic: Agricultural land with organic certification (typically meaning no use of synthetic pesticides or fertilizers) compared to land where synthetic pesticides and fertilizers are applied.
6. Reduced tillage: No till or low till, compared to conventional tillage.

We are working to add several other practices to the module in a future update:

7. Agroforestry: Woody plants (trees, shrubs) planted sequentially or simultaneously with productive crops (e.g. alley cropping, multistrata systems, parklands, hedgerows, sylvopasture), compared to cropland without woody plants.
8. Intercropping: At least two crop species planted simultaneously on the same agricultural land, usually in alternate rows or strips, compared to land used to cultivate a single crop species

9. Organic amendments: Organic fertilizers (manure, mulch, biogas residue) compared to mineral fertilizers, biochar amendment compared to no biochar, residue retention compared to residue removal.
10. Crop rotation: Productive crops grown in succession on the same agricultural land, compared to land repeatedly planted with a single crop.
11. Holistically managed grazing: Strategic rest grazing (SRG) compared to conventional grazing (CG).

For each practice, users can adjust assumptions regarding the future share of cropland on which the practice is used, and how quickly any change in the proportional coverage (increase or decrease) will occur. The user can select one practice on its own or a combination of up to three practices (e.g. organic farming, reduced tillage and embedded natural).

Methods

Estimating baseline for coverage of agroecological practices

Information is not readily available on the area of cropland under agroecological practices. We compiled estimates of the existing area coverage by developing spatially explicit indicators from a variety of sources, detailed in Table 1. Each indicator was overlaid on SPAM 2010 commodity distribution data (IFPRI, 2019) and Natural Earth v.5.1.1 (2024) administrative boundaries to obtain an estimate of the cropland under each practice per country and commodity. We were not able to identify suitable coverage data for cover crops and cultivar mixtures.

Table 1: Data sources used to compute baseline practice coverage.

Agroecolo-gical practice	Indicator for practice	Data year	Timeseries available	Data source	Limitations
Diversified farming systems	Share of cropland with a crop group richness >=20 per 10x10km, calculated from SPAM 2010 data.	2010	No (not with all crops included in SPAM 2010 version)	mapSPAM 2010 (IFPRI, 2019)	How many crop groups should be present per 10x10km for it to be safe to assume crops are planted in diversified systems? Assumed here 20 crop groups, but this needs checking with local knowledge and data.
Embedded natural	Cropland with >20% natural or semi-natural land per 1x1km, calculated from ESA LULC 2015 data	2015	Yes (can be computed for 1992 to 2020 on an annual basis)	Share of natural land in cropped landscapes maps from Jones et al. (2021), derived from the ESA CCI 2015 land cover map	There is evidence that all agricultural landscapes need >20% natural or semi-natural vegetation to maintain biodiversity and ecosystem functioning (e.g. Garibaldi et al. 2021; Mohamed et al. 2024). We use 20% as the cut off for counting cropland as having enough embedded natural vegetation. Users could use a lower

					threshold. Note that the calculation of % natural or semi-natural vegetation is made by aggregating land cover classes in ESA data which is available at 300 x 300m resolution. This land cover data includes a 'mosaic cropland and natural vegetation' class which may capture some fine landscape features (e.g. hedgerows) but this is not guaranteed. The estimates could be recomputed using higher resolution land cover maps where these exist.
No / minimal tillage	Reduced or no tillage represents cropland with values >1 in the tillage dataset where: 1 = conventional annual tillage, 2 = traditional annual tillage, 3 = reduced tillage, 4 = Conservation Agriculture, 5 = rotational tillage, 6 = traditional rotational tillage, 7 = Scenario Conservation, Agriculture area	2005	No	Porwollik et al. (2019), which presents global maps of 7 tillage systems for 42 crop types, for around the year 2005.	Effects of agricultural soil management can be assessed by soil, crop, and ecosystem models but global assessments are hampered by lack of information on soil management systems.
Organic	Organic agriculture as share of total farmland	2010	Yes (2000, 2005, 2010, 2015, 2020)	FiBL survey based on national data sources, data from certifiers, Eurostat, downloaded 14 April 2023. See statistics.fibl.org	Data are not disaggregated to commodity level.

Source: the authors.

Users are encouraged to replace or complete estimates of current coverage of agroecological practices if they are aware of better datasets for their country or region.

Estimating historical yield

Historical yields per commodity were already computed in the model, derived from FAOSTAT production and area per commodity (FAOSTAT, 2024). For details, see the FABLE

Calculator documentation (Mosnier et al. 2021 – update in prep.). We assume that the changes in yield occur within 5 years following a change in agricultural practice.

Estimating historical biodiversity intactness

We used a global biodiversity intactness index (BII) map to assess historic levels of biodiversity per land use and per country and region. The BII is an "aggregated indicator of the average abundance of a large and diverse set of organisms in a given geographical area, relative to their reference population", with the reference condition approximated by the contemporary situation in minimally impacted sites (Scholes and Biggs, 2005; Phillips et al. 2021). It includes plants and vertebrates (plants, mammals, birds, reptiles and amphibians) and excludes invertebrates and microbes. We used the BII map from Sanchez Ortiz et al. (2019) and calculated the mean BII per land cover class and per country using the ESA 2020 land cover map and Natural Earth v.5.1.1 (2024) administrative boundaries. We aggregated the scores to FAO land cover classes (cropland, pasture, other land, forests, urban) to obtain one biodiversity score per land cover and country or region. We assume that the changes in biodiversity occur within 5 years following a change in land use or agricultural practice.

Estimating historical soil organic carbon (SOC)

Historical soil organic carbon stocks were calculated from estimates of SOC at 0-30cm depths obtained from FAO's Global Soil Organic Carbon (GSOC v1.5) map (1km x 1km resolution). We calculated the mean SOC per commodity group and per land cover class for each country, using SPAM 2010 v2.0 physical production area maps (IFPRI, 2019), ESA 2020 land cover maps and Natural Earth v5.1.1 (2024) administrative boundaries. As per the IPCC Tier 1 recommendations, we assumed that, when land use change occurs, SOC stocks in each land cover class transition to a new equilibrium SOC stock in a linear fashion over a period of 20 years. We assume that the changes in SOC stocks related to changes in agricultural practices happen within a 5-year time-step.

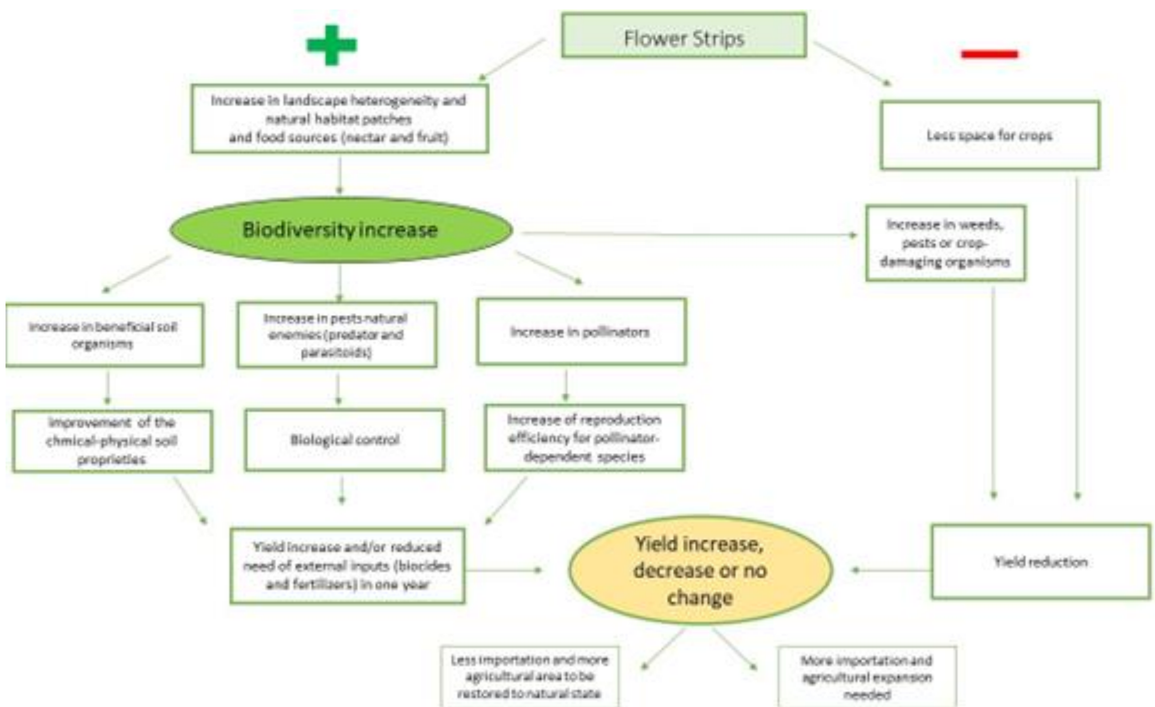
Estimating historical agricultural employment and costs

See documentation of the agricultural cost module in Vittis et al. 2022.

Estimating the effects of shifting agricultural practices

Shifting from intensively managed monocultures to agroecological practices has variable effects on yield, biodiversity, soil health, carbon sequestration and storage, water quality (Tamburini et al. 2020; Beillouin et al. 2021), production costs and farming system profitability (Sánchez et al. 2022). These effects can vary by region, crop type, surrounding landscape complexity, and other factors. For example, natural regeneration of flower strips adjacent to productive land is considered an agroecological practice. Flower strips increase the complexity and heterogeneity of the agricultural system and can provide new food resources, shelters, nesting and breeding sites for multiple species, including pollinators, pests, and natural enemies of crops. An increase in pollinators and natural enemies can benefit yields, but an increase in pests together with a loss of productive land can negatively affect yields (Figure 2). Overall effects on biodiversity and yield therefore depend on several factors such as the crop type, flower strip composition, and surrounding landscape context.

Figure 2: Pathways through which flower strips affect biodiversity and yield.



Source: the authors.

In the agroecology module, estimated effects represent the proportional change in biodiversity, yield, SOC stock and costs in a treatment compared to a control, where a positive value reflects an increase, zero value reflects no change, and negative value reflects a decrease. For example, the overall global effect on biodiversity of agroforestry relative to monocultures is estimated at 0.61 in Beillouin et al. (2021), meaning that there is on average 61% more biodiversity in farming systems with woody plants compared to systems with no woody plants.

To estimate the effect of a shift in the area coverage in one or more agroecological practices on biodiversity, agricultural yields, stock of soil organic carbon (SOC) and labour, we used estimates from global meta-analyses. Meta-analyses are statistical models used to synthesize quantitative data from multiple primary studies reporting observations from field experiments. We extracted estimates from a selection of meta-analysis as detailed in Table 2. Those shifters are present in the FABLE Calculators in the worksheet 3_data_demand, in table AgPrac_coefs.

Table 2: Effects of agroecological practices on yield, biodiversity, soil organic carbon (SOC), and labour input Estimates, sample size, and source

Practice	**Crop group**	**Yield shifter***	**Source**	**Biodiversity shifter***	**Source**	**SOC shifter***	**Source**	**Labor shifter***	**Source**
Cover crops	(Intercept only model)	6.0% (3657)	Beillouin et al. 2021	21.0% (4625)	Beillouin et al. 2021	12.8% (2943)	Beillouin et al. 2023	52% (32)	Sanchez et al. 2022**
	Cereals	57.1% (69)	Jones et al. 2021	-20.0% (143)	Jones et al. 2021				
	Fibres			-2.0% (197)	Jones et al. 2021				
	Fruits	-16.2% (18)	Jones et al. 2021	103.8% (519)	Jones et al. 2021	23.7% (406)	Beillouin et al. 2023		
	Oil crops			-0.1% (40)	Jones et al. 2021				
	Vegetables	-33.4% (15)	Jones et al. 2021	-40.9% (151)	Jones et al. 2021				
Cultivar mixtures	(Intercept only model)	2.0% (7688)	Beillouin et al. 2021	20.0% (94)	Beillouin et al. 2021	1.4% (161)	Beillouin et al. 2023		
	Cereals			-17.9% (21)	Jones et al. 2021				
	Fibres			17.0% (60)	Jones et al. 2021				
	Oil crops			6.6% (100)	Jones et al. 2021				
	Vegetables			-4.5% (68)	Jones et al. 2021				
Diversified farming practices	(Intercept only model)	2.2% (224)	Jones et al. 2021	19.9% (3332)	Jones et al. 2021	11.8% (15384)	Beillouin et al. 2023 ***	35.0% (278)	Sanchez et al. 2022**
	Cereals	2.3% (129)	Jones et al. 2021	16.1% (896)	Jones et al. 2021				
	Fibres			3.9% (305)	Jones et al. 2021				
	Fruits	-9.2% (26)	Jones et al. 2021	77.7% (642)	Jones et al. 2021				

	Nuts / Stimulants			28.3% (406)	Jones et al. 2021				
	Oil crops			-2.8% (249)	Jones et al. 2021				
	Roots and tubers			51.8% (33)	Jones et al. 2021				
	Vegetables	68.3% (33)	Jones et al. 2021	-14.1% (583)	Jones et al. 2021				
Embedded natural	(Intercept only model)	-5.8% (24)	Jones et al. 2021	92.5% (326)	Jones et al. 2021	17.2% (47)	Beillouin et al. 2023 ****	37.0% (7)	Sanchez et al. 2022**
	Cereals	-37.5% (12)	Jones et al. 2021	143.3% (157)	Jones et al. 2021				
	Fruits		Jones et al. 2021	82.2% (60)	Jones et al. 2021				
	Oil crops		Jones et al. 2021	38.0% (40)	Jones et al. 2021				
	Vegetables		Jones et al. 2021	101.7% (22)	Jones et al. 2021				
No / Minimal tillage	(Intercept only model)	-5.3% (8020)	Tamburini et al. 2020	60.4% (214)	Tamburini et al. 2020	7.8% (345)	Tamburini et al. 2020	-15.1%	Pearsons et al. 2023 *****
	Cereals	-5.0% (4359)	Pittelkow et al. 2015	19.8%	Bowles et al. 2016				
	Oil crops	0.7% (447)	Pittelkow et al. 2015						
	Pulses	-2.6% (1063)	Pittelkow et al. 2015	43.5%	Bowles et al. 2016				
	Roots and tubers	-21.4% (69)	Pittelkow et al. 2015						
Organic farming	(Intercept only model)	-19.2%	Ponisio et al. 2015	34.0%	Tuck et al. 2014	33.8%	IPCC guidelines Tier 1	19.0% (35)	Crowder and Reganold (2014)**
	Cereals	-21.4%	Ponisio et al. 2015	42.0%	Tuck et al. 2014			25.7% (10)	Crowder and Reganold (2014)**
	Fruits	-6.6%	Ponisio et al. 2015	30.4%	Tuck et al. 2014				

	Nuts / Stimulant	-12.7%	Ponisio et al. 2015	34.5%	Tuck et al. 2014				
	Oil crops	-29.0%	Ponisio et al. 2015	34.5%	Tuck et al. 2014				
	Roots and tubers	-6.6%	Ponisio et al. 2015	34.5%	Tuck et al. 2014				
	Vegetables	-16.9%	Ponisio et al. 2015	30.4%	Tuck et al. 2014				

*Source: the authors. Notes: * Sample size in parenthesis when available. ** For Sanchez et al. 2022 and Crowder and Reganold 2014, we used their dataset of primary articles to compute global difference averages (one extreme outlier has been removed for Crowder and Reganold 2014). *** Estimate for diversified farming practices is computed as the weighted mean of the estimates of agroforestry, cover crops, crop mixtures, crop residues, intercropping and no/minimal tillage from Beillouin et al. 2023. **** Estimate of hedgerows from Beillouin et al. 2023, the practice that was best matching embedded natural. ***** Pearsons et al. 2023 is not a meta-analysis, data come from a field experiment.*

Please, note that we did not find estimates in labour input change under cultivar mixtures.

Ensuring consistency between the agroecology practice and nutrient application assumptions

In addition to the changes listed above, we amended the model assumptions on nutrient applications to account for the fact that transitioning from non-organic farming systems to organic farming systems implies a switch from synthetic fertilizer to organic fertilizer. For each hectare of land under organic farming, units of synthetic fertilizers are replaced by the equivalent quantity in organic fertilizer (manure). At present, there are no constraints in the model on the local organic fertilizer availability.

Applying Agroecological Practice Scenarios

Here we provide step by step instructions on how a FABLE Calculator user can develop scenarios for future changes in agroecological practice coverage.

Step 1. Defining the alternative scenario of interest

In the FABLE Calculator, alternative scenarios are defined in the SCENARIOS definition worksheet, where values in all green cells may be modified by users to fit their national or regional context. Users define their scenarios for the evolution of agroecological practice coverage in table S.21.a. AgPracLookup (Figure 3).

By default, in the FABLE Calculators, there are 8 different scenarios:

- NoChange: the share of adoption of agroecological practices remains constant over time
- Cover_crops: scenario with evolution of cover crop coverage
- Cultivar_mix: scenario with evolution of cultivar mixture coverage
- Diversified: scenario with evolution of diversified farming practice coverage
- Embed_nat: scenario with evolution of embedded natural coverage
- Organic: scenario with evolution of organic farming coverage
- Reduce_till: scenario with evolution of no/minimal tillage coverage
- Mixed: scenario with evolution of the coverage of a combination of 3 different practices, by default organic farming, no / minimal tillage and embedded natural.

Figure 3. Screenshot of the S.21.a AgPracLookup table in the SCENARIOS definition worksheet

TABLE: AgPracLookup

DIRECT	DIRECT		DIRECT	DIRECT	DIRECT	DIRECT	DIRECT	DIRECT	DIRECT	DIRECT	DIRECT
S.21.a											
Share of cultivared area under each agroecological practice in each scenario											
				Target of planted area under all agroecological practices by 2050 (cannot be lower than the maximum targeted area across all practices)	Name of the targeted agroecological practice 1	Historical share of planted area under agroecological practice 1	Target of planted area under the first agroecological practice by 2050	Name of the targeted agroecological practice 2 (in the mixed scenario)	Target of planted area under the second agroecological practice by 2050	Name of the targeted agroecological practice 3 (in the mixed scenario)	Target of planted area under the third agroecological practice by 2050
				% of planted area		“% of planted area	% of planted area		% of planted area		% of planted area
SPAMgroup	**AgPracScen**	**ProductScen**	**ImplTiming**	**TotalAgPracTarget**	**AgPrac1**	**Current1**	**AgPrac1Target**	**AgPrac2**	**AgPrac2Target**	**AgPrac3**	**AgPrac3Target**
cereals	Diversified	cerealsDiversified	Linear	0%	Diversified_farmin	28%					
fibres	Diversified	fibresDiversified	Linear	0%	Diversified_farmin	26%					
fruits	Diversified	fruitsDiversified	Linear	0%	Diversified_farmin	27%					
nuts	Diversified	nutsDiversified	Linear	0%	Diversified_farmin	13%					
oilcrops	Diversified	oilcropsDiversified	Linear	60%	Diversified_farmin	43%	60%				
pulses	Diversified	pulsesDiversified	Linear	50%	Diversified_farmin	24%	50%				
roots_and_tubers	Diversified	roots_and_tubersD	Linear	0%	Diversified_farmin	30%					
stimulant	Diversified	stimulantDiversifie	Linear	0%	Diversified_farmin	25%					
sugar_crops	Diversified	sugar_cropsDiversi	Linear	0%	Diversified_farmin	41%					
vegetables	Diversified	vegetablesDiversif	Linear	0%	Diversified_farmin	25%					
cereals	Organic	cerealsOrganic	Linear	20%	Organic_farming	2%	20%				
fibres	Organic	fibresOrganic	Linear	20%	Organic_farming	2%	20%				
fruits	Organic	fruitsOrganic	Linear	20%	Organic_farming	2%	20%				

Source: Reference FABLE Calculator UP48.

For the six scenarios that concern one practice only, users must specify for each crop group:

- the target planted area under the practice by 2050 (column [AgPracTarget])
- the implementation timing rate (column [ImplTiming]). For more information on the role of implementation timing rate, please refer to the FABLE Calculator documentation (Monsier et al. 2021).

For example in Figure 3, for oil crops, the coverage of diversified farming practices (column [AgPrac1]) will increase linearly from 43% (column [Current1]) in 2020 to 60% of the planted area in 2050; for pulses, it will increase from 24% to 50% over the same period.

It is important to note that:

- As there is no targeted number for other crop groups in column [AgPracTarget], the coverage of diversified farming practices for those groups will remain constant at the current (2020) value. For all crop groups, coverage share of the other practices will also remain constant over time.
- If the target value is lower than the baseline value, the scenario has no impact on practice coverage. Check the current value in column [Current1], to see the current coverage value associated with the SPAM group and first practice selected (column [AgPrac1]).
- Cells from columns [AgPrac2] to [AgPrac3Target] are crossed out as this scenario apply to one practice only.
- The scenario will be applied only when it is selected in the Pathways Definition worksheet.

- Targets are expressed as share of cropland, thus agroecologically managed area evolves automatically with cropland expansion or reduction independently from the scenario definition.

The last scenario is a mix of three different practices (Figure 4). Users must specify for each crop group:

- the implementation timing rate
- the first practice name included in the mix and its target planted area by 2050
- the second practice name included in the mix and its target planted area by 2050
- the third practice name included in the mix and its target planted area by 2050.

For example in Figure 4, for all crop groups, the total coverage of agroecological practices will be 70% of the planted area in 2050, including 70% of embedded natural, 20% of organic farming and, for some crop groups, 30% of no / minimal tillage. It is important to note that:

- By default, the targeted total coverage is the largest targeted practice and not the sum of the different practices. This means we assume the agroecological practices are applied concurrently on the same areas instead of being implemented in different regions.
- In the table, the current coverage data is displayed for the first practice only. For other practices, users need to refer to other scenarios or to table AgPracArea in 3_data_crops.
- The effect of the different practices on yields, biodiversity on cropland, SOC stocks and labour will be weighted by the percentage coverage and summed (i.e. interaction effects are not explicitly considered).

Figure 4. Screenshot of the Mixed scenario in the S.21.a. AgPracLookup table in the SCENARIOS definition worksheet

TABLE: AgPracLookup

S.21.a

Share of cultivared area under each agroecological practice in each scenario

DIRECT	DIRECT		DIRECT	DIRECT	DIRECT	DIRECT	DIRECT	DIRECT	DIRECT	DIRECT	DIRECT
				Target of planted area under all agroecological practices by 2050 (cannot be lower than the maximum targeted area across all practices)	Name of the targeted agroecological practice 1	Historical share of planted area under agroecological practice 1	Target of planted area under the first agroecological practice by 2050	Name of the targeted agroecological practice 2 (in the mixed scenario)	Target of planted area under the second agroecological practice by 2050	Name of the targeted agroecological practice 3 (in the mixed scenario)	Target of planted area under the third agroecological practice by 2050
				% of planted area		"% of planted area	% of planted area		% of planted area		% of planted area
SPAMgroup	**AgPracScen**	**ProductScen**	**ImplTiming**	**TotalAgPracTarget**	**AgPrac1**	**Current1**	**AgPrac1Target**	**AgPrac2**	**AgPrac2Target**	**AgPrac3**	**AgPrac3Target**
cereals	Mixed	cerealsMixed	Linear	70%	Organic_farming	2%	20%	No_minimal_tillage	30%	Embedded_natural	70%
fibres	Mixed	fibresMixed	Linear	70%	Organic_farming	2%	20%	No_minimal_tillage	30%	Embedded_natural	70%
fruits	Mixed	fruitsMixed	Linear	70%	Organic_farming	2%	20%	No_minimal_tillage		Embedded_natural	70%
nuts	Mixed	nutsMixed	Linear	70%	Organic_farming	2%	20%	No_minimal_tillage		Embedded_natural	70%
oilcrops	Mixed	oilcropsMixed	Linear	70%	Organic_farming	2%	20%	No_minimal_tillage	30%	Embedded_natural	70%
pulses	Mixed	pulsesMixed	Linear	70%	Organic_farming	2%	20%	No_minimal_tillage	30%	Embedded_natural	70%
roots_and_tubers	Mixed	roots_and_tubersM	Linear	70%	Organic_farming	2%	20%	No_minimal_tillage	30%	Embedded_natural	70%
stimulant	Mixed	stimulantMixed	Linear	70%	Organic_farming	2%	20%	No_minimal_tillage		Embedded_natural	70%
sugar_crops	Mixed	sugar_cropsMixed	Linear	70%	Organic_farming	2%	20%	No_minimal_tillage		Embedded_natural	70%
vegetables	Mixed	vegetablesMixed	Linear	70%	Organic_farming	2%	20%	No_minimal_tillage		Embedded_natural	70%

Source: Reference FABLE Calculator UP48.

Box 1. How to create new agroecological scenarios?

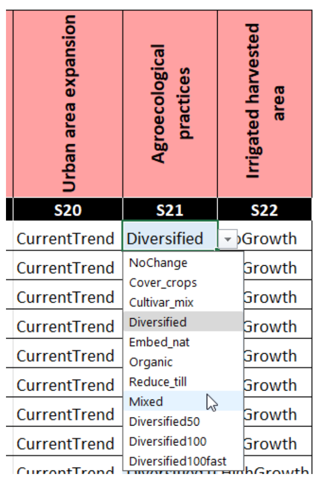
On top of modifying the existing agroecological practice scenarios, users can add as many agroecological practice scenario as they want. To do so, they have to follow four steps:

1. In the worksheet SCENARIOS definition, in AgPracLookup table, add 10 lines at the bottom of the table. Specify the SPAM groups (copy paste the list from another scenario). Make sure that formulas have been extended in columns that have one.
2. Decide the name of your new scenario in column [AgPracScen]. As for the other scenarios, decide the implementation rate, the practices that will evolve and their targeted plant area coverage by 2050.
3. In the worksheet SCENARIOS selection, in AgPractice_Scen table, add a line and specify the name of your new scenario in the column [AgPrac_Scen].
4. In the worksheet PATHWAYS selection, in the column [Agricultural Practices], verify that the name of your new scenario have been added to the drop down list. If not, define again the list by selecting the scenarios names in the worksheet SCENARIOS selection, in AgPractice_Scen table.

Step 2. Select the scenario you want to apply

In the PATHWAYS selection worksheet, users must specify the scenario they will apply by selecting it from the drop-down list (figure 5). The default is 'NoChange'.

Figure 5. Screenshot of PATHWAYS selection



Source: Reference FABLE Calculator UP48.

Step 3. Computation process

Once the scenario has been selected (in the PATHWAYS selection worksheet) and defined (in the SCENARIOS definition worksheet), the targeted coverage for agroecological practices is computed over the period between the calibration year and 2050. Main steps happen in different worksheets as detailed in Table 3.

Table 3. Computation process

Worksheet	Table number	Table	Computation
SCENARIOS Definition	S.21.b.	AgPracTarget	The table computes shifters of yield, biodiversity, SOC and labour changes implied by the AgPrac scenario at the crop group level based on coefficients extracted from the literature and populated in the worksheet 3_data_demand in the table AgPracArea depending on the agroecological practice coverage in the calibration year and the targeted coverage in 2050.
SCENARIOS Definition	S.21.c.	AgPracDef	The table computes the average shifter in 2050 (compared to the calibration year) per crop group combining all agroecological practices and applies the implementation timing rate to have a shifter per time step during the implementation period. Shifters in columns [ShifterYield], [ShifterBio], [ShifterSOC] and [ShifterLabour] are the ones that will be applied to the corresponding indicators in the calculation worksheets.
3_calc_crop	3.B	Calc_crops	The table computes the targeted production and harvested area by crop and emissions related to rice cultivation. In particular, final productivity is computed, taking into account agroecological practices, as well as the cropland area under agroecological practices and the biodiversity score for cropland.
6_feas_crops	6.C	Calc_FeasCrops	The table recomputes the crop production in case of land scarcity (if no land scarcity, results should be the same as in calc_crops). Feasible cropland under agroecological practices and biodiversity score in total feasible planted area are also computed depending on land scarcity.
8_calc_emissions	8.C	Calc_cropemis	The table computes the GHG emissions associated to the crop production and SOC stock per crop. The evolution of SOC stock accounts for coverage of agroecological practices.
8_calc_emissions	8.F	Calc_SOCemis	The table computes SOC stock per land cover and time-step.
10_calc_costs	10.A	Calc_cropcosts	The table computes the agricultural costs for 10 crops (barley, groundnut, maize, potato, rice, sorghum, soybean, sugar beet, sunflower, and wheat) including fertilizer, pesticides, labor, fuel, and depreciation and running costs for machinery. Labor inputs are adjusted to the agroecological practice coverage. Fertilizer adjust also to organic farming coverage, replacing synthetic fertilizer by organic fertilizer coming from manure on such area.
10_calc_costs	10.C	Calc_employment	The table computes the labor inputs and employment costs for all crops and livestock products. Labor inputs for crops adjust with agroecological practice coverage.
10_calc_costs	10.D	Calc_NPKuse	The table computes synthetic and organic fertilizer use for all crops. Organic fertilizer increases with organic

			farming coverage (implying a proportional decrease in synthetic fertilizer).

Source: the authors.

Step 4. Outputs

The scenarios for agroecological practice coverage directly affect several indicators in the model, including indicators for biodiversity, GHG emissions and agricultural employment (Table 4). Through its impacts on yield, agroecological practice coverage indirectly affects nearly all indicators in the model, in particular food security and land based indicators.

Table 4. Key indicators affected by changes in agroecological practice coverage

Key indicator	Worksheet	Table
Evolution of cropland under agroecological practices (in percentage of total cropland and in thousand of hectare).	BIODIVERSITY	ResultsAgroecoPractices
Evolution of biodiversity scores per land cover type and average for the country/region.	BIODIVERSITY	ResultsBioScore
Employment in the agricultural sector	JOBS	ResultsJobs
GHG emissions from land through SOC stock changes	GHG	ResultsGHG
Total fertilizer use per fertilizer type (synthetic or organic)	SCENATHON_report	Reporting_aggregate
Total costs for the ten crops concerned	PRODUCTION SCENATHON_report	ResultsCosts Reporting_byproduct

Source: the authors.

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