

Dynamic Management Tool for Agroforestry

Prajna Kasargodu Anebagilu,
INRES Horticultural Sciences

Rheinische Friedrich-Wilhelms-Universität Bonn



REFOREST



Funded by
the European Union

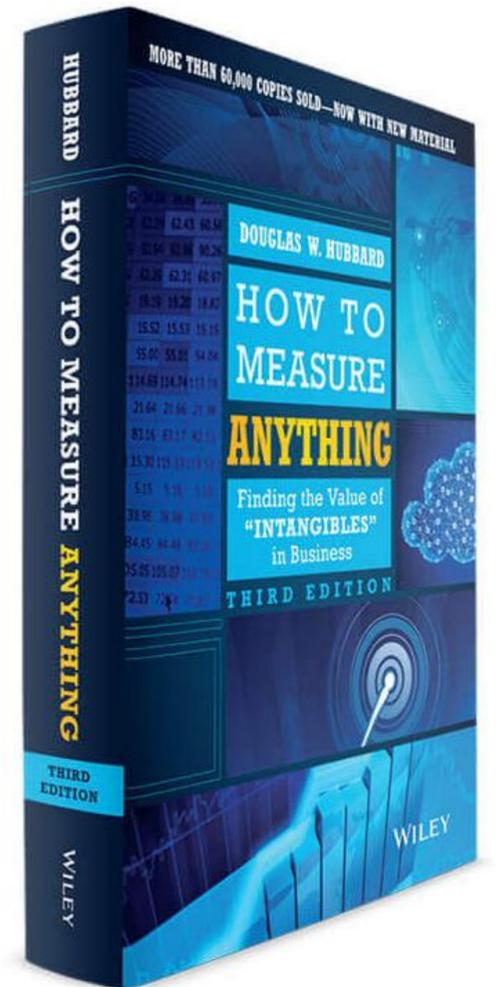


INRES
HORTICULTURAL SCIENCES

Dynamic Management Tool

Based on the Decision Analysis Approach

- Capture what is known and apply this knowledge to generate forecasts of decision outcomes.
- From business and economics to agriculture
- When to use this approach?
 - For systems that are too complex to fully understand (with available resources)
 - For supporting decisions that must be made without perfect information
 - “What’s the best option according to our limited understanding?”

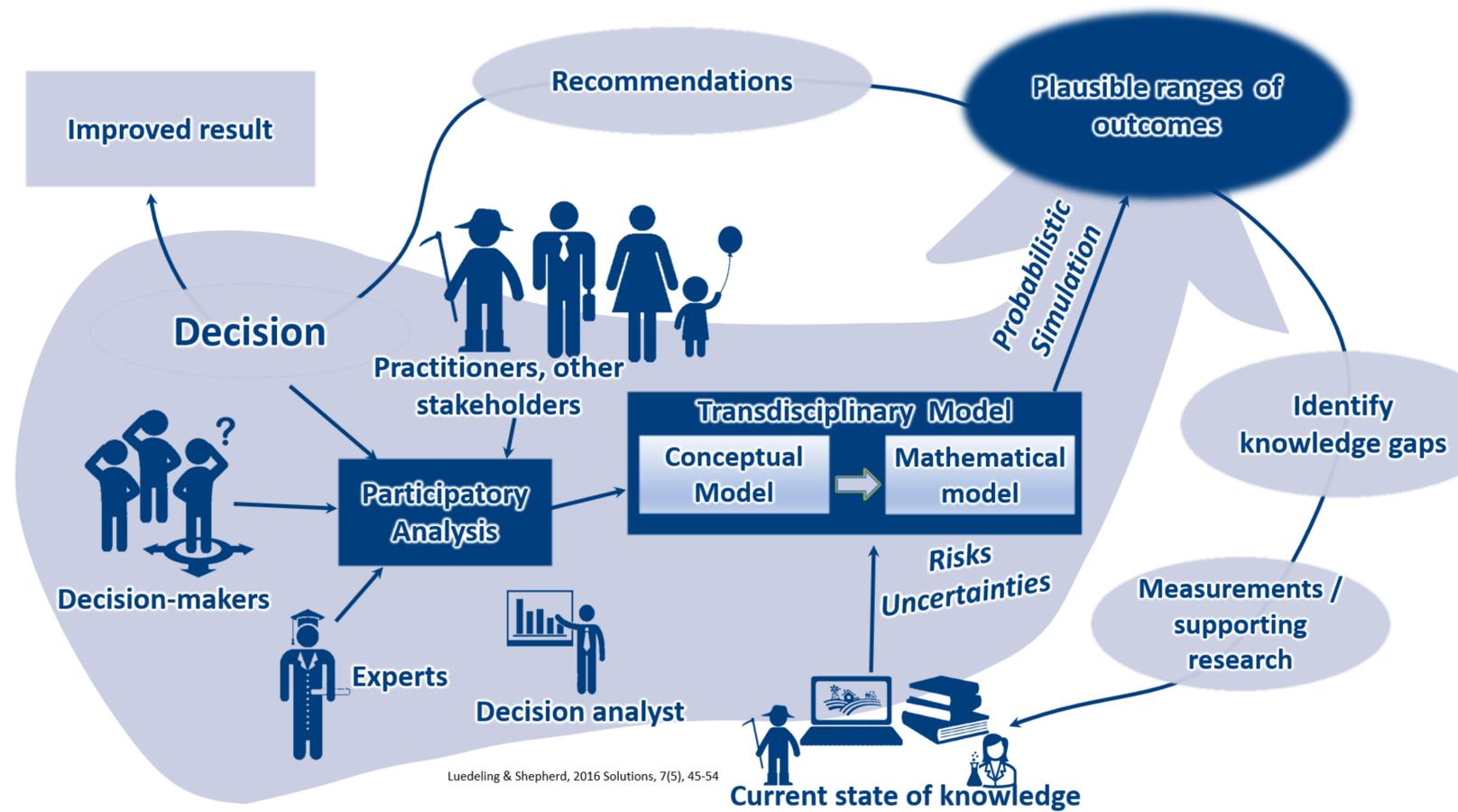
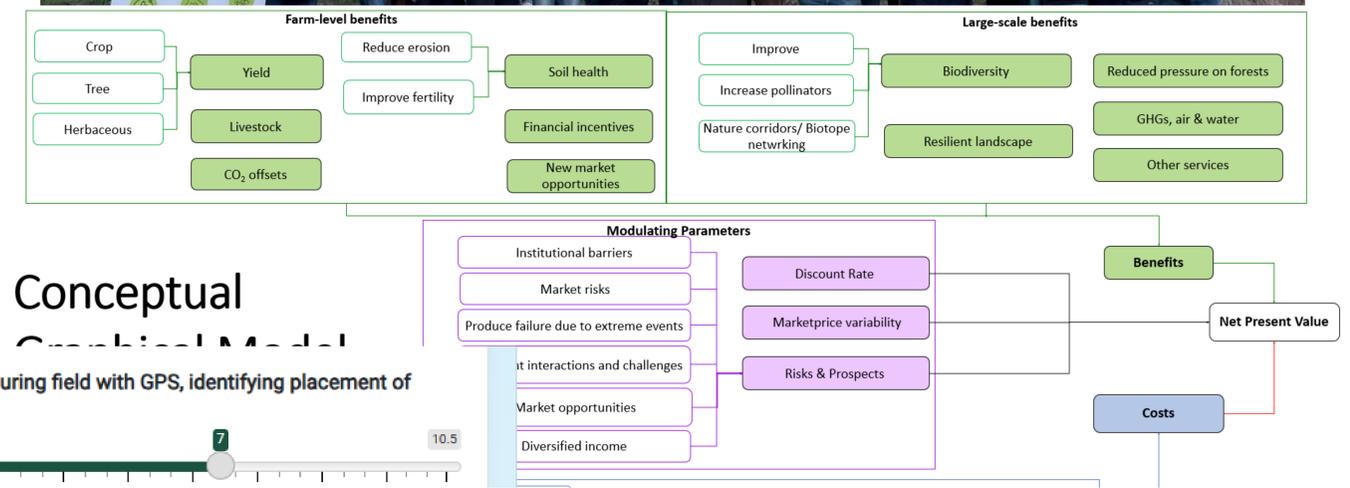




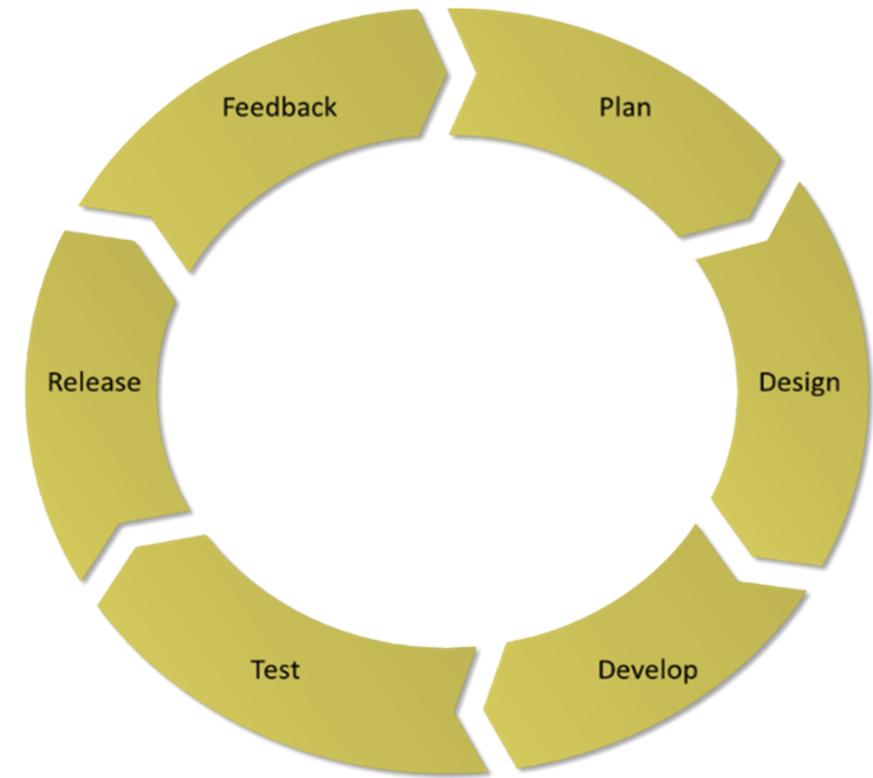
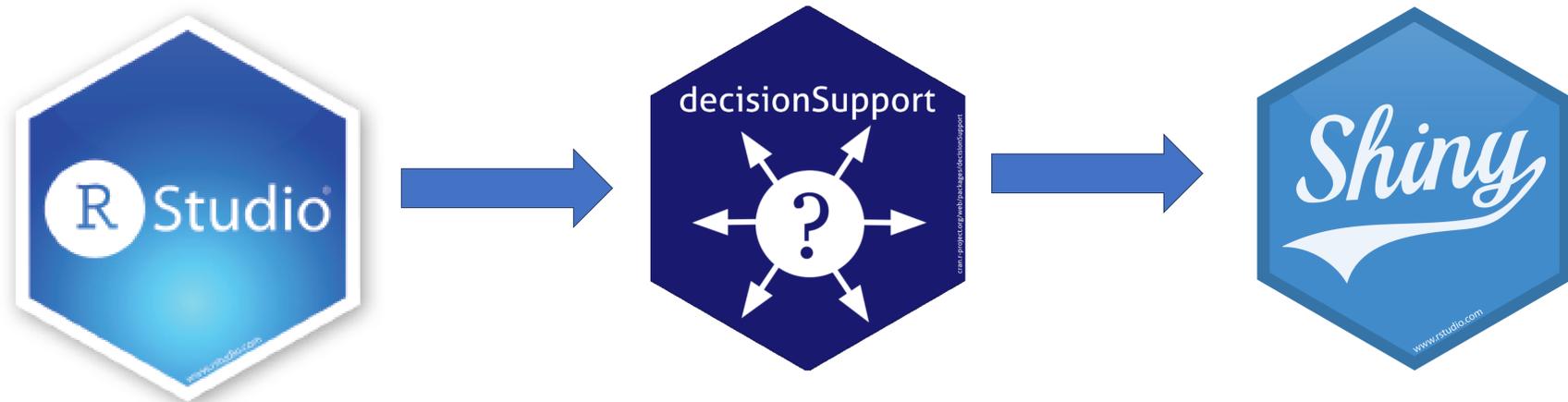
Dynamic Management Tool

Key principles of Decision Analysis Approach

- Include everything that matters
- Model system using all sources of information, including local and expert knowledge
- Explicitly consider uncertainties about inputs, processes and outputs (probabilistic models)
- Identify key uncertainties for measurement using 'Value of Information' analysis
- Update model, when new information becomes available



Dynamic Management Tool: Development process



Agile Development Process

```

#Crop rotation in AF system
AF_einkorn_yield[einkorn_indices] <-
  vv(AF_einkorn_yields, cv_einkorn_yield, length(einkorn_indices)) * (1 - perc_yield_reduction[einkorn_indices]) *
  Arable_area_AF #* AF_chance_perc_crop_fall * AF_chance_perc_weather_fall
AF_einkorn_benefit <- vv(einkorn_price, cv_einkorn_price, n_years) * AF_einkorn_yield

AF_wheat_yield[wheat_indices] <-
  vv(AF_wheat_yields, cv_wheat_yield, length(wheat_indices)) * (1 - perc_yield_reduction[einkorn_indices]) *
  Arable_area_AF #* AF_chance_perc_crop_fall * AF_chance_perc_weather_fall
AF_wheat_benefit <- vv(wheat_price, cv_wheat_price, n_years) * AF_wheat_yield

AF_dinkel_yield[dinkel_indices] <-
  vv(AF_dinkel_yields, cv_dinkel_yield, length(dinkel_indices)) * (1 - perc_yield_reduction[einkorn_indices]) *
  Arable_area_AF #* AF_chance_perc_crop_fall * AF_chance_perc_weather_fall
AF_dinkel_benefit <- vv(dinkel_price, cv_dinkel_price, n_years) * AF_dinkel_yield

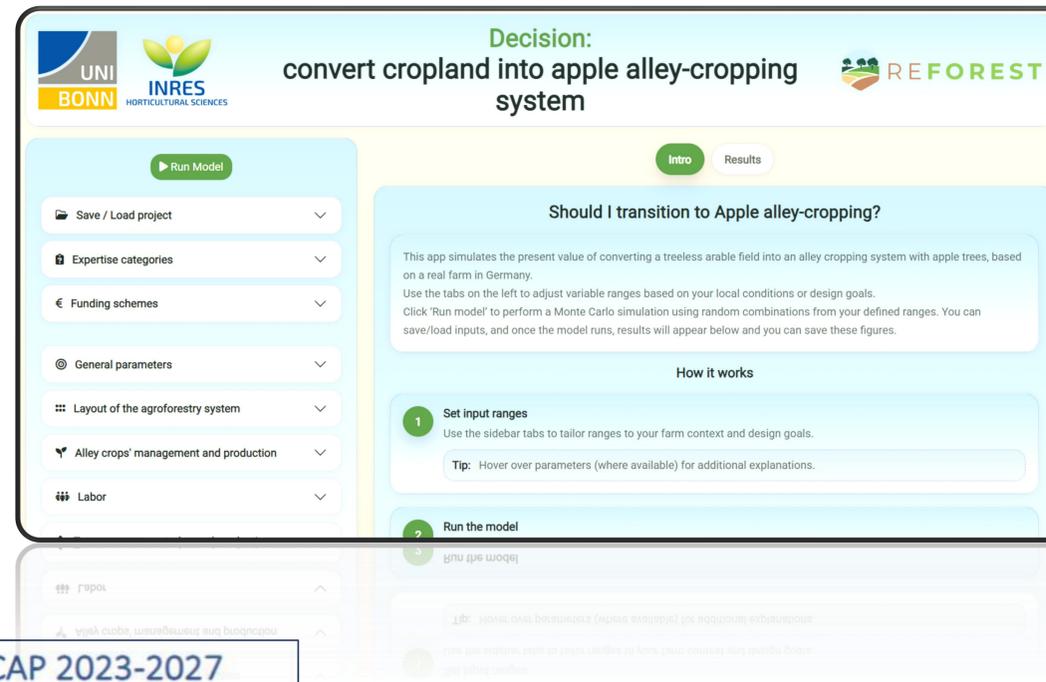
#tree component - nuts in AF system
AF_nuts_yield <- rep(0, n_years)
ES3_subsidy <- rep(0, n_years)

#yield of one nut tree [kg/tree]
AF_nuts_yield <- gomp_fit_yield(
  yield_max,
  estimate = time_to_first_nuts,
  first_yield_percent = nuts_yield_first,
  second_yield_estimate_percent = nuts_yield_second,
  n_years = n_years,
  var_cv = var_cv,
  no_yield_before_first_estimate = TRUE
)

#yield of all nut trees [kg] considering risks
AF_tot_nuts_yield <-
  AF_nuts_yield * num_trees #* AF_chance_perc_crop_fall * AF_chance_perc_weather_fall

#calculate how many kg have nuts quality and can therefore be marketed at a higher price (Pack_nuts) and
#the rest are used for making oil
pc_pack_nuts <- vv(perc_pack_nuts, var_cv = var_cv, n_years) / 100
Pack_nuts_yield <- AF_tot_nuts_yield * pc_pack_nuts
oil_nuts_yield <- AF_tot_nuts_yield * (1 - pc_pack_nuts)

#the benefits from nuts are calculated by multiplying their yields by their respective prices
Pack_nuts_benefit <-
  vv(Pack_nuts_price, var_cv, n_years) * Pack_nuts_yield
oil_nuts_benefit <-
  vv(oil_nuts_price, var_cv, n_years) * oil_nuts_yield
  
```



European Agroforestry Institutional Support-Scheme Database as per CAP 2023-2027
(ReForest project)

Prajna Kasargodu Anebagilu¹, Andrew Marcil¹, Simon Swatek¹, Paweł Radzikowski², Robert Borek², Červená Tereza³, Hochmalová Miroslava³, Vity Andrea⁴, Albert Miquel Colom Bauza⁵, Stefka Atanasova⁶, Tom Staton⁷, Will Simonson⁸, Willem Van Colen⁹, Rico Huebner¹⁰, Eike Luedeling¹



REFOREST



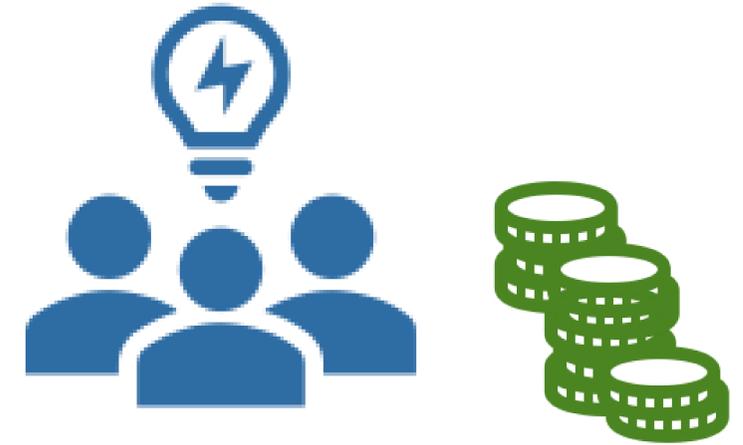
Dynamic Management Tool: Users



FreeSVG



Flaticon



- Adopt agroforestry for current farm conditions?
- Change farm management or design to ensure stacking up?
- What financial support measures are available for the transition?

- Evaluate the impact of policies and regulations at the farm scale
- Design better and transformative policies

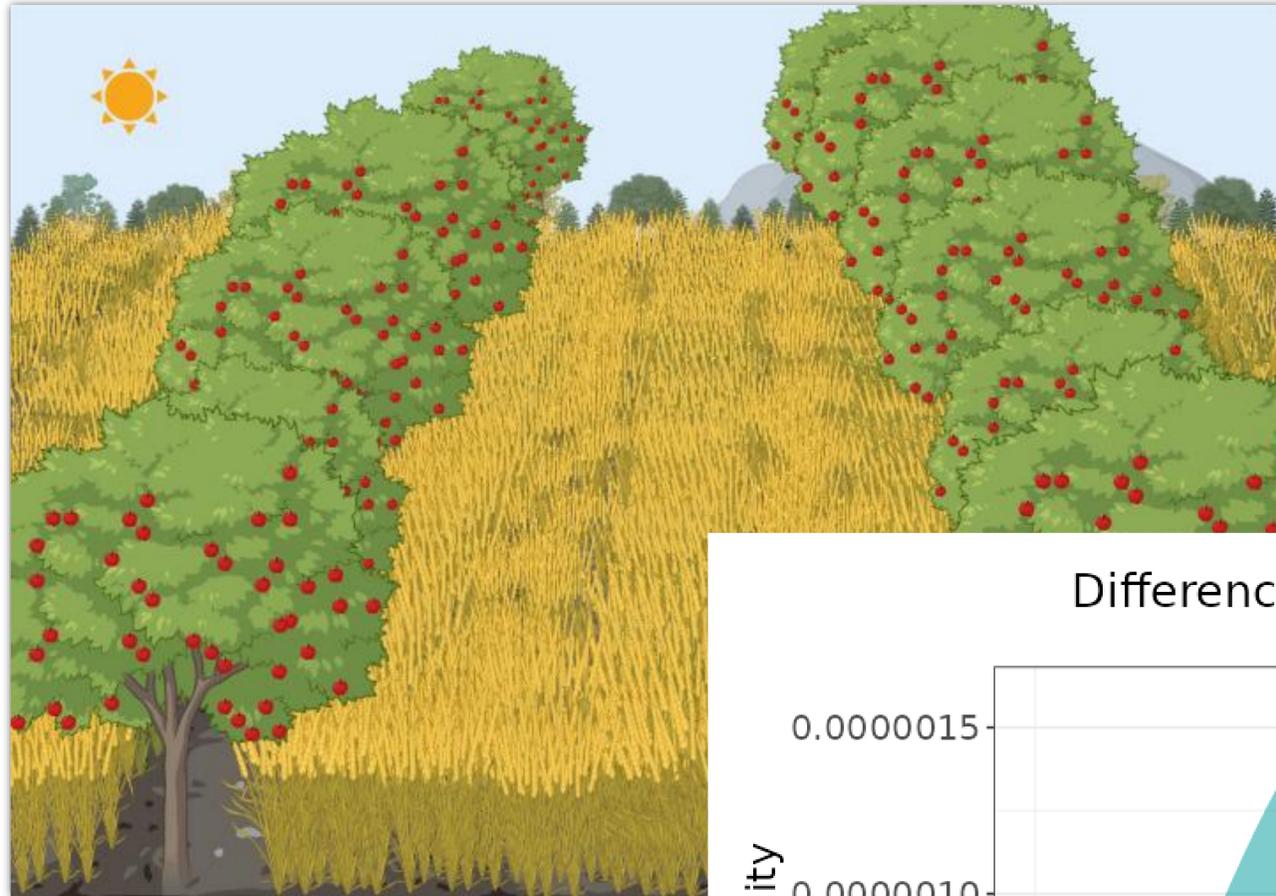
- Assess potential returns, risks and env. benefits
- Align with financial and sustainability objectives



Dynamic Management Tool

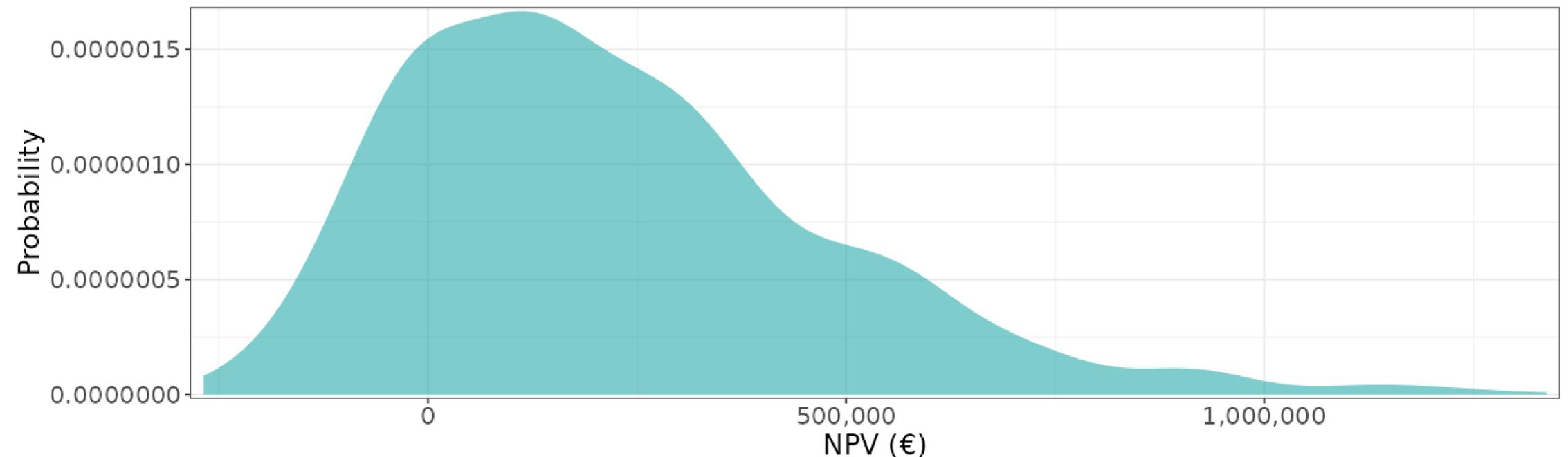
App 1 – Germany

Silvoarable system with apple production



- Comparison of apple agroforestry (can be any fruit) with treeless option
- Promising, but risky without support payments
- How does support scheme design affect profitability?

Difference between agroforestry and treeless farming under identical conditions



<https://agtools.app/Apple-Agroforestry/>



REFOREST⁶



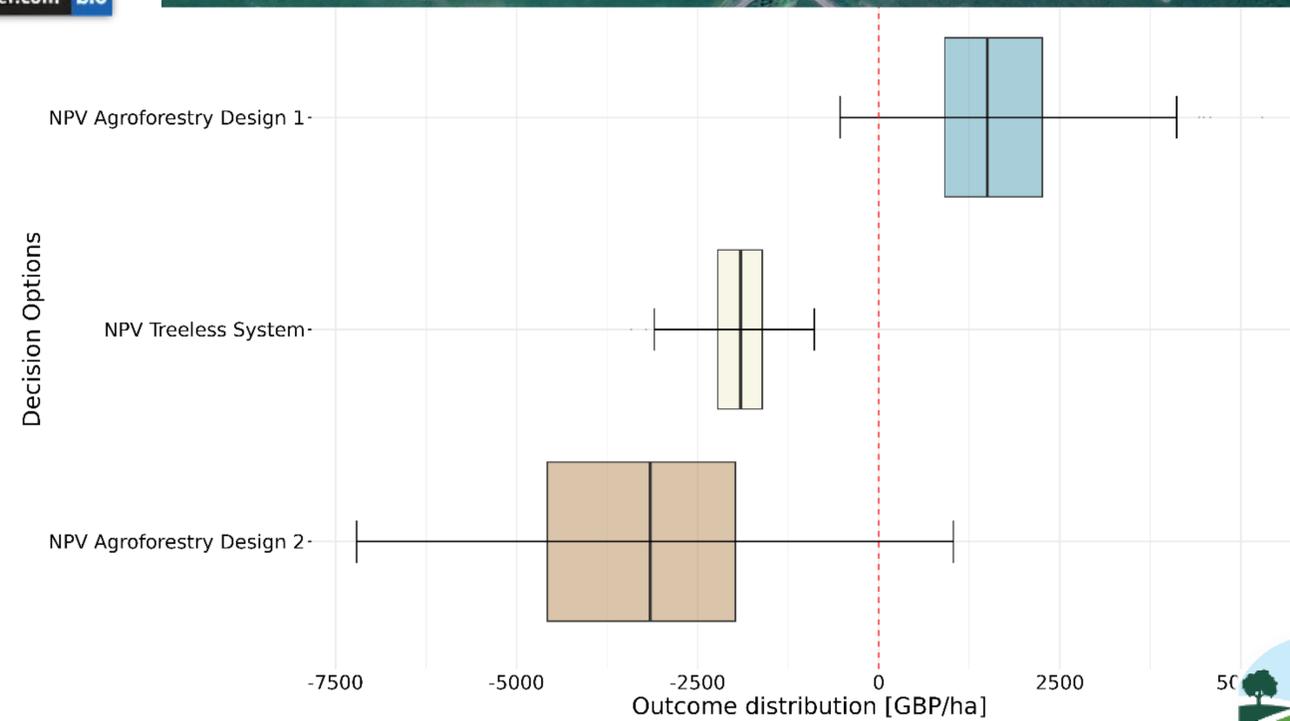
Funded by the European Union

Dynamic Management Tool

App 2 – United Kingdom Silvopastoral designs



- Comparison of 2 designs
- Ecosystem benefits
- Major differences in expected outcomes



<https://agtools.app/Silvopastoral-Livestock/>

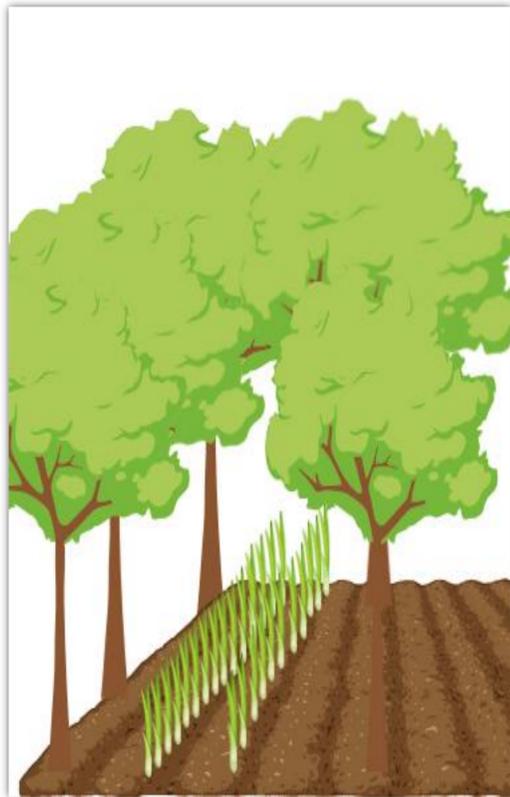


REFOREST⁷



Dynamic Management Tool

App 3 – Belgium Walnut alley-cropping and hedges



General parameters

Timescope [years]
80

Discount rate [%]
19

Crop rotation alternative
1

Agroforestry alternative
1

Model iterations
1000

General coefficient of variation [%]
46

Layout of the agroforestry system

Intervention's surface area [ha]
1,4

Selected Financial Supports

| Funding Category | Total Financial Support |
|---|-------------------------|
| Funding Onetime Percentage Initial Cost Schemes | 0.75 |
| Onetime External Support | 20000.00 |
| Annual External Support | 2000.00 |

Figure 1. Probabilistic distributions of Net Present Value

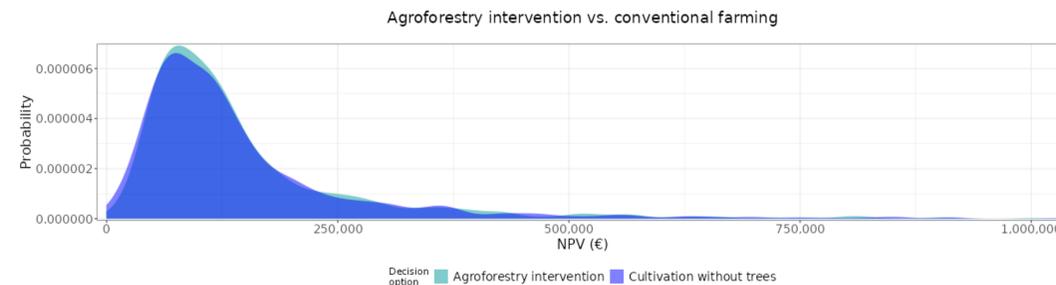


Figure 1 shows the Net Present Value (NPV) distributions of the decision to establish the alley cropping system (green) and the decision to continue farming without planting trees (blue) for the timescope of interest. The x-axis displays NPV values (i.e., the sum of discounted annual cash flows) and the y-axis displays the probability of each NPV amount to occur (i.e., higher y-values indicate higher probability).

- With vegetable production
- Carbon dynamics and ecosystem services



<https://agtools.app/Walnut-Agroforestry/>



REFOREST⁸

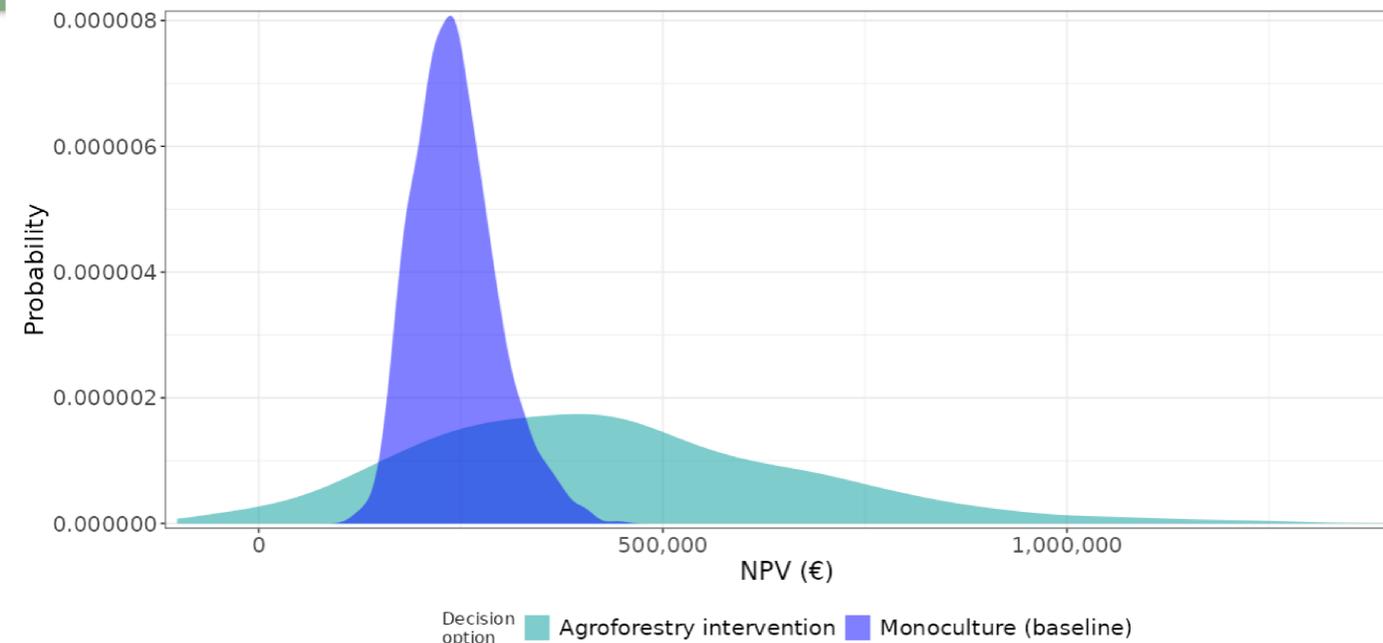


Dynamic Management Tool



- App 4 – Germany
 Fruit & honey with *Streuobstwiese*
- Fruit trees selected for year-round honey production
 - Unique design
 - Much wider range of outcomes than the conventional option

Agroforestry intervention vs. conventional farming



<https://agtools.app/Fruit-Honey/>



REFOREST⁹



User Interface and Catalogue of Systems



A silvopastoral agroforestry system, as planned for one of the Living Labs in England. It also compares 2 agroforestry designs.



A multispecies fruit tree system with honey production and a traditional meadow orchard based on a plan for an AF farm in Germany.

© HortiBonnTeam

An alley cropping system with apple trees based on a real farm in Germany.



© HortiBonnTeam

A walnut alley cropping system with vegetable rotation on a demonstration plot (Living Lab) in Belgium.



© HortiBonnTeam



REFOREST



Funded by the European Union