Bridging complexity for hybrid perspectives: Modifying the Bass system dynamic & Roger's agent-based diffusion of innovation models to explore the adaptation of industrial hemp farming in Ireland (WIP)

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Research Problem

The hemp industry has been slow to grow in Ireland. This compares to France, the third-largest industrial hemp producer in the world and the largest producer in Europe.

Research Question

What conditions must change for Irish landowners to adapt to farming hemp?

Purpose

The Hemp In Agriculture for Carbon Sequestration (HACS) System Dynamic (SD) Agent-Based Model (ABM) with Geographic Information System (GIS) explores the diffusion rate of landowners' decisions to apply for licences to farm hemp in Ireland and tests the determinants based on the availability of processing facilities and the loosening of strict regulations.

Summary

The area of multi-method hybrid modelling is attracting growing attention because of its ability to gain perspectives from a top-down and bottom-up perspective using SD and ABM. The original contribution to knowledge is a multi-method hybrid SD and ABM that includes a GIS. There is no evidence in the literature of an integrated SD and ABM model to ascertain the drivers affecting landowners' decisions to farm hemp in Ireland. This work explores the relationship between the two modelling paradigms and contributes to understanding this complex system, following Bass and Rodgers. A CLD is built in Vensim and imported into NetLogo. The ABM is programmed, and the SD and network extensions are used. Future work simulates the diffusion of hemp with an integrated hybrid SD ABM GIS model. The predictions from the hybrid model can be compared to known outcomes regarding the national adoption of hemp. The work concludes with thoughts on the design of hybrid simulation models.

Introduction

- SD (mathematical) and ABM (computational) are popular modelling paradigms. Despite their common goal, these methods are rarely combined in agriculture. Combining them would be advantageous in creating more accurate hybrid models. This study investigates possible ways to combine these methods.
- .The HACS SD ABM model is an abstract model for theoretical exploration and hypothesis generation. To consider the model realistic enough for its purpose, the behaviour patterns can be observed against seven years of empirical data. The model is programmed in NetLogo using the SD modeller, Network and GIS extensions.
- The HACS model includes two entities: landowners and policymakers. The key attribute of the agents is that landowners can decide whether to apply for a licence to farm hemp or not. Policymakers can ease or restrict application rules. Proto agent, availability of processing facilities, changes in regulations by decision-makers. The environment is mapped by a polygon shapefile obtained from Ordnance Survey Ireland. Using the GIS extension to visualise the observed adaption and rate of speed of landowners in applying for a licence to farm Hemp.
- The model acts as a visualisation tool for stakeholders, representing the diffusion of landowners applying for a licence to farm Hemp in Ireland.

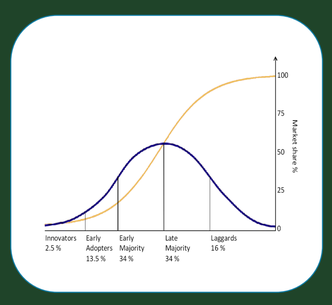
Software

VENSIM PLE 9.3.4

- CLD & stock and flow diagram

NETLOGO 6.2.0

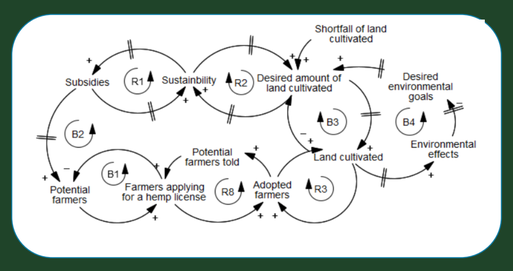
- Import CLD extract.
- SD extension - Stock & flow diagram
- Network extension - Preferable attachment network
- Geographic Information System (GIS) extension
- Ireland Shapefiles



Results

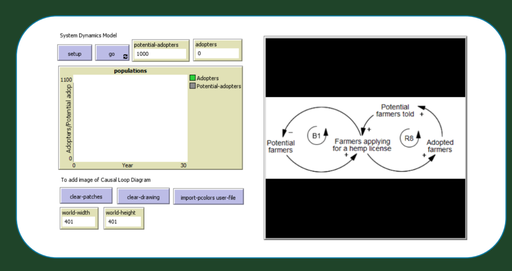
CAUSAL LOOP DIAGRAM (CLD)

- Developed in Vensim



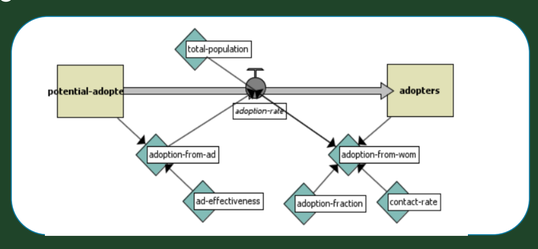
Extracted from CLD

- CLD image imported into NetLogo
- Potential adopters & adopters. loops B1 & R8



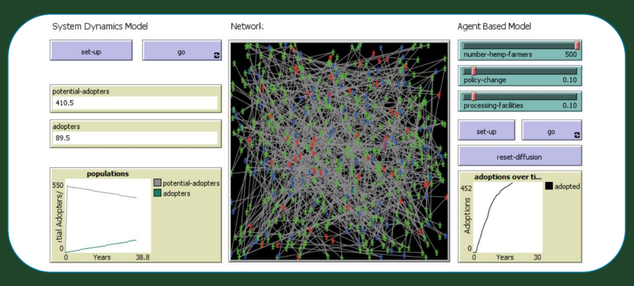
Stock and flow diagram developed in NetLogo

- In the SD extension, the variables word-of-mouth and ad-effectiveness relate to policy change and processing facilities sliders in the agent-based model interface.



Bass SD & Rogers ABM with preferable attachment network

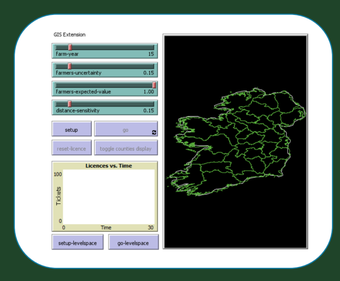
- Model implementation & interface
- Repeated every time step is the landowner's decision to apply for a licence or not.
- Policymakers can decide to ease regulations if there is an increase in the hemp farming population if there is no change in business-as-usual.



- Processing facilities are either more widely available or not, accessed from a slider on the interface from 1 to 100%

GIS extension

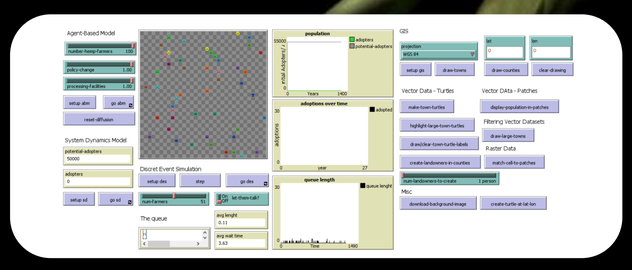
- Ireland dataset
- Counties dataset
- Heatmap
- Based on cow patch model



- Each landowner asks, "Will I apply for a licence to cultivate Hemp? If yes, then the number adds to the population of the location county and is represented using the scaling colour green from light to dark where counties have more licences issued.
- Each landowner asks, "Will I apply for a licence to farm Hemp? If no, then no change.

Extending the Model

- HACS Hybrid GIS
- Extensions [nw queue gis csv ls]
- **4 views in behaviour space**



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Acknowledgements

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