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TOWARDS A POWERFUL KNOWLEDGE DATABASE TO THINK OUTSIDE THE BOX AND SELECT MULTI-PURPOSE PLANTS

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Abstract: Knowledge on plant uses is often compartmentalized into fields. Our hypothesis is that if a plant species allows several uses of interest, in different fields, then its cultivation and formulation may be of interest to new value chains. Establishing a knowledge database on multi-purpose plants is one way of facilitating interactions between disciplines, in addition to proposing new solutions to be explored in organic or ecological farming. This paper describes how to construct such a Knowledge Database. A comparison between the uses present in the different tabs makes it possible to identify 16 plant species reported for at least four different uses.

Introduction: The organic movement inspires science or should inspire it (De Bon et al., 2018). Indeed, not using synthetic chemical pesticides in agriculture, or antibiotics in livestock farming, is guiding research towards alternative solutions. To enhance organic farming, especially in Africa, and find the four scientific roots of IFOAM (ecology, health, fairness, care), interdisciplinary research is necessary. It is at the heart of the IPM concept and the One-Health initiative.

Inspired by the results of the European ADAPPT (2017) and OPTIONs (2017) projects, our work aims to replace synthetic pesticides and antibiotics with natural plant-based substances, particularly aqueous extracts or essential oils, or even whole plants (used in fish farming, Sarter *et al.*, 2011). The conceptual approach adopted is the one described by Gliessmann (2016) in Phase II of his transition for food systems.

Using plants is a known traditional practice in some countries, applied in the case of certified organic production. The French list of biocontrol products includes rare plant-based formulations, such as natural pyrethrums. Some formulations containing azadirachtin, derived from neem (*Azadirachta indica*), are allowed in organic agriculture.

However the development of these products remains limited in agriculture for several reasons, including those mentioned by Stevenson *et al.* (2014). Lack of knowledge about their toxicity to non-targeted organisms (Vertebrates or Invertebrates), is one of the reasons. The availability of plant material, its large-scale multiplication in the field, its conservation and its transformation into formulations are additional constraints.

Knowledge on plant uses is often compartmentalized according to fields: cosmetics, bioenergy, crop protection, public health and insect vectors, animal health, human health and plants used in traditional medicine. This separation into disciplinary "silos" does not make it easy to identify multi-purpose species.

Our hypothesis is that if a plant species allows several uses of interest, in different fields, then its cultivation and formulation may be of interest to new value chains. It is therefore necessary to identify such multi-purpose plants.

In the context of increasing international trade, the problem of invasive alien species is also a concern. Knowledge about their management by plants in their region of origin is not readily available on newly invaded continents.

This is why establishing a powerful knowledge database on multi-purpose plants that is easily accessible to users with different needs, is a way of breaking out of the box, facilitating interactions between disciplines, and proposing new solutions to be explored in organic or ecological farming.

Material and methods: *Knowledge management database: data origin and structure.*

Knowledge about plant uses is disseminated through multiple media: journal articles, books (books, manuals and practical guides), databases, websites.

In order to group and enter the different selected uses in an easy-to-implement way, several matrices have been established in a single Excel file. A matrix is constructed by thematic tabs, each theme being a plant use in a particular field (plant and animal health, dye plants, service plants including cover crops, biofuel plants, plants for paralysing fish, food plants, plants useful for soap making, nectar plants). The current database includes eight (8) main tabs. Dictionaries are used to correct input errors. Additional tabs describe trophic chains between organisms.

For each matrix, the Latin names of the plant species are placed in rows in the first column.

The following columns contain the attributes associated with each row, information that comes from bibliographical consultations and defined in relation to the chronology of the consultation. Additional attributes/columns can thus be added to the right-hand side of the matrix, notably experimental results such as Lethal Dose 50 (LD50), for example.

The "plant and animal health" tab is at the origin of the initial *Knomana* knowledge database resulting from the Glofoods INRA-CIRAD project of the same name. The research began with a survey of articles published in French-speaking sub-Saharan African countries, notably Cameroon and Burkina Faso, partner countries. It continued on a broader geographical scale, on the African continent and then on other continents.

One line in the matrix represents an experimental, or non-experimental (already adopted in the field) use of a plant extract applied at a given dose - when specified - to protect an organism (plant, animal) from the harmful effects of an antagonistic target organism (pests, diseases of various origins, including *Varroa* of bees for example). Publications mentioning unintended effects are also considered. They describe the effects of the extracts on non-target organisms such as, for example, telluric organisms (earthworms), aquatic organisms (daphnia), beneficial arthropods (natural enemies, pollinators), or plants (phytotoxicity of the extract).

The search in reference databases, such as Web of Science, was done with the keywords "pesticidal plants" and "Africa". To provide references not reported in the 'classic' reference databases, the members of the informal French-speaking network PPAf (Plantes Pesticides d'Afrique), set up in 2015, were interviewed. Their feedback led to the retrieval of other publications. A complementary approach was taken by particular topics, such as plants grown in organic farming, by sector (cocoa, cotton), or particular pests such as ticks or invasive alien species, such as the insects *Spodoptera frugiperda* or *Tuta absoluta*. As the volume of references is substantial, not all articles - or reviews of articles - have yet been entered. A database (Zotero) groups the analysed articles saved in pdf format. An operating licence granted to the contributors ensures the protection of these data.

Content of the knowledge base

Articles have been entered manually. Review articles enable the incorporation of a lot of information at once, without reaching the level of detail of the original articles cited. An analysis and redistribution of tables are required to isolate each use by line. If an extract has been tested at several doses against several target species, each dose and each species is the subject of one line in the matrix. The same applies to the geographical origins of the plants, detailed if the information exists, in order to take into account the potential existence of chemotypes. A degree of reliability is attributed to the analysed publication. Any work that does not identify the chemical composition of the applied extracts is considered to be of secondary interest, but kept.

Results: At the current stage of data entry in the literature, a comparison between the uses present in the different tabs makes it possible to identify the plants reported for at least four (4) different uses (Table 1). Of them, the species used for fishing (column 7) could or should be forbidden for field crop protection.

Table 1 Extract from knowledge database: species of plants mentioned for at least 4 uses.

Plant species	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Allium cepa	X		X	X		X	
Anacardium occidentale	X		X	X		X	
Annona muricata	X		X	X			X
Balanites aegyptiaca			X	X	X		X
Brassica rapa	X		X	X			
Carica papaya	X		X	X			X
Cocos nucifera	X	X		X		X	
Curcuma longa	X		X	X		X	
Helianthus annuus	X	X		X		X	
Jatropha curcas		X	X	X			X
Laurus nobilis	X		X	X		X	
Mangifera indica	X		X	X		X	
Momordica charantia	X		X	X			X
Parkia biglobosa	X		X	X			X
Ricinus communis	X	X	X	X			
Trichilia emetica			X	X	X		X

Legends of uses: (1) Food (2) Biofuel (3) Animal (and human) health (4) Plant health (5) Soap (6) Natural colour dye (7) Plants used for fishing

Discussion: In October 2019, the “plant, animal and human health tab” contained 2119 species of plant species. An exploration method is being drawn up to identify local plants to solve locally current or new sanitary issues (Keip *et al.*, 2019).

References: ADAPPT (2017): http://projects.nri.org/adappt/

De Bon H et al. (2018): https://doi.org/10.19182/agritrop/00036

Gliessman SR (2016): The five level of food systems transformation. *In* : AFSA 2016. Agroecology: The Bold future of Farming in Africa. AFSA & TOAM. Dar es Salaam. Tanzania, 84-85.

Keip P et al. (2019): Effects of input data formalisation in Relational Concept Analysis for a data model with a ternary relation. 15th International Conference on Formal Concept Analysis 2019. Lecture Notes in Computer Science 11511, Springer, 191-207.
OPTIONs (2017): http://projects.nri.org/options/9-about-the-project
Sarter S et al. (2011): Antimicrobial effects of essential oils of *Cinnamosma fragrans* on the bacterial communities in the rearing water of *Penaeus monodon* larvae. Vector-borne and zoonotic diseases 11, 433-437.
Stevenson PC et al. (2014): Chapter 9: Pesticidal plants for stored product pests on small-holder farms in Africa. In: *Advances in plant biopesticides*, D. Singh (ed.), 149-172.

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