TITLE

Field Cultivation Index, a new method for assessing agricultural practices sustainability and moving towards regenerative agriculture in cosmetic supply chains.

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ABSTRACT

In the context of climate change, it becomes of upmost importance to limit the impact of industrial activities on the environment. Utilizing more bioresources exposes, increasingly, supply chains to agriculture stakes. Therefore, biomasses sustainable cultivation practices are crucial to support resilient transition. This requires tools to assess the environmental performance of cultural systems. However, the existing tools are not adapted to the specific operational realities

of cosmetic supply chains. This is why we developed the Field Cultivation Index (FCI) with a threefold aim: 1. assess cultural systems strengths and weaknesses and guide for possible improvement; 2. compare cultural systems to identify the most environmentally performing; 3. promote initiatives undertaken and efforts made. This article describes the FCI methodology and exposes the initial results from the evaluation of about 40 diversified cultural systems. Finally, it discusses the benefits, limitations, and potential uses of this tool for monitoring the environmental impact of cultural systems within cosmetics supply chains.

KEYWORDS

Regenerative agriculture; Field cultivation index; Multicriteria assessment tool; Sustainable agricultural practices; Bioresources.

INTRODUCTION

In the context of climate change, it becomes of upmost importance to limit the impact of industrial activities on carbon emission, water stress, biodiversity loss and natural resources depletion [1, 2]. Utilizing more bioresources exposes, increasingly, supply chains to agriculture stakes. Therefore, biomasses sustainable cultivation practices are crucial to support transition towards resilience [3, 4].

In this context, the cosmetic has a responsibility to set specific research programs and to commit to operate within the planetary boundaries to mitigate the impact of all its activities on climate, water, biodiversity and natural resources. Our common climate change objective is to align our greenhouse gas emissions to the +1.5°C scenario on scopes 1, 2 and 3 [5].

Nowadays more and more of cosmetic's raw materials are derived from renewable sources, and from many species of plants, in all regions of the world. And a huge work is done by many groups to develop formula with biobased ingredients.

Cosmetic research has been working for many years also to ensure high water quality and sustainable water quantity across all its value chain, and throughout the watersheds it operates in.

In a context where agriculture in particular, is threatening planetary boundaries and resilience to climate change, sourcing ingredients in a sustainable and responsible manner is therefore a pre-requisite to act effectively on limiting environmental impacts [6].

There are many agricultural models that aim to reduce their environmental impact (reasoned, extensive, precision, etc.) [7]. Some, often grouped under the heading of sustainable agriculture or agroecology, propose structural changes to production methods to maximize the ecosystem services provided by agroecosystems (soil conservation agriculture, organic farming, etc.) [8, 9] Within this landscape, regenerative agriculture is emerging as an innovative approach with ambition to restore agroecosystems. Regenerative agriculture has recently undergone significant development, driven by industrials who see it as a promising and pragmatic approach [10, 11]. Although there is no agreed definition of Regenerative agriculture [9–11] the various initiatives have a number of common points. In addition to ambitious social considerations in favor of farmers and landscapes, 5 environmental outcomes are regularly mentioned [12, 13]:

1. Soil, with the aim of improving soil quality.

2. Water, with the aim of managing water resources.

3. Biodiversity, with the aim of preserving and developing it in agroecosystems.

4. Pests and weeds, with the aim of reducing the use of chemicals.

5. Carbon, with the aim of sequestering carbon and limiting its emissions.

To respond to these environmental outcomes, regenerative agriculture proposes an approach to the conservation and rehabilitation of agricultural and food systems that aims firstly to protect and then enhance the agroecosystem providing services in return [10].

These different outcomes are not independent of each other [12]. For example, soil quality influences its capacity to store carbon [14]. Similarly, reducing the use of pesticides is associated with a reduction in pollution, with positive effects on biodiversity and water resources [15]. This is why regenerative agriculture implies a holistic vision of agricultural activity [13] requiring the implementation of a set of agricultural practices [10, 12, 13].

On the field, professionals need to be able to address these 5 environmental outcomes and propose improvements based on recognized sustainable practices. To achieve this, they need tools to assess the environmental performance of cultural systems (set of agricultural practices used to produce a crop) [10, 13]. However, these tools are generally not well adapted to operational realities, particularly in supply chains producing bioresources used in cosmetics [3, 10, 12, 16]. Most of the existing tools focus on the farm level, whereas the economic players mainly think in terms of supply chains (and therefore crops). In addition, they often focus on specific context like plant species (annuals, perennials, etc.) grown in specific regions of the world (temperate climate, tropical climate, etc.), whereas cosmetic supplies involve a wide variety of plant species grown in many regions of the world [17]. Finally, data collection often requires considerable resources when supply chains are complex and with multiple intermediaries.

With this in mind, we developed the Field Cultivation Index (FCI). The aim of this tool is threefold: 1. assess cultural systems strengths and weaknesses to guide for possible improvement; 2. compare cultural systems to identify the most environmentally performing; 3. promote initiatives undertaken and efforts made. It also meets the specific operational challenges of the cosmetics industry: i) simple (data collection is easy and straightforward), ii) deployable in all regions of the world (diversity of soils and climates, etc.), iii) adapted to all cropping systems (industrial, family, etc.) and all plant species (perennials, annuals, etc.).

To date, the FCI does not address social aspects, which are already managed by tools developed and implemented within organizations. The FCI does not address livestock breeding, not relevant for the supply chains studied here.

In this article, we describe the FCI methodology in detail. We present the initial results from the evaluation of about 40 cultural systems with diverse profiles in terms of crop type (annual plant, perennial plant), production method (more or less simplified, organic certified or not, etc.) and location and climate (temperate, Mediterranean, arid and tropical). Finally, we discuss the benefits, limitations, and potential uses of this tool for monitoring the environmental impact of a cultivated plant biomass supply chain.

MATERIALS and METHODS

The "Field Cultivation Index" (FCI) is a qualitative index evaluating cultural systems regarding the 5 environmental outcomes identified in regenerative agriculture (see introduction): 1. Soil (improving quality); 2. Water (managing resources); 3. Biodiversity (preservation and development in agroecosystems); 4. Pests and weeds (reduce the use of chemicals); 5. Carbon (sequestration and limitation of emissions)

This easy-to-use tool is based on scientifically recognized evaluation methods (IDEA [18], TAPE [19], IR [20], HVE [21], DiagAgroEco [22]) and economic operators initiatives (ROA [23], Regenagri [24], Regenerative agriculture scorecard [25]) and has been adapted to the specific operational context of the cosmetic-related supply chains presented in the introduction. Fig-1 summarizes the 6 phases of the FCI methodology.

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┌─────────────────────┐       ┌─────────────────────┐
│   I. List of 31     │ ═══>  │  II. 31 agricultural │
│ agricultural        │       │  practices scores   │
│ practices (AP)      │       │  (APS)              │
└─────────────────────┘       └─────────────────────┘
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┌──────────────────────────┐      ┌──────────┐      ┌──────────┐
│ III. AP scores assignment│ ═══> │  IV. 5   │ ═══> │  V. FCI  │
│ to the 5 environmental    │      │   EO     │      │          │
│ outcomes (EO)             │      └──────────┘      └──────────┘
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┌──────────────────────────┐
│  VI. Improvement         │
│  recommendations         │
└──────────────────────────┘
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I. 31 agricultural practices are classified in 3 categories (A, B, C) depending on their level of impact on the environment. These 31 practices are evaluated for a given cultural system

II. The 31 agricultural practices are scored depending on their deployment intensity and weighted according to the practice category (A, B, C)

III. The 31 AP scores are assigned to the 5 environmental outcomes

IV. Computation of the environmental outcomes (EO) scores leads to 5 "Environmental outcomes index"

V. Field cultivation index (FCI) is calculated from the average of the 5 "Environmental outcome index"

VI. Improvement practices recommendations are drawn up on the basis of the FCI assessment

Fig-1. Schematic summary of the FCI calculation method

I.   *Constitution of agricultural practices list*

The FCI methodology is based on the evaluation of 31 agricultural practices (listed in Table I) frequently mentioned in technical and scientific literature about regenerative agriculture and agroecology and requiring few resources for evaluation (qualitative data are sufficient). They cover both recognized sustainable agronomic techniques (the use of cover crops, rotation diversity, etc.) and "AgTechs" (innovative agricultural technologies such as connected tools, use of robots, etc.).

The 31 practices have been characterized according to 2 key criteria: i) Their global impact on the environment ii) Their specific impact on each of the 5 environmental outcomes identified in regenerative agriculture.

i)   Global impact on the environment

The practices are classified (see Table I) into 3 categories (A, B and C). This classification elaboration is based on criteria found in other evaluation methods (mentioned above), technical and scientific literature (references summarized in Table I) and experts' opinion. Practices referenced as most important in regenerative agriculture are included in category A, while those described as less regenerative are included in category C. Category B includes practices having intermediate effect. The most regenerative practices will be weighted by a factor of 4 for cat A, 2 for cat B and 1 for cat C (see phase II and Table II below).

ii)   Specific impact on the 5 environmental outcomes

The impact of the 31 practices has been characterized in relation to the 5 environmental outcomes identified in regenerative agriculture (summarized in Table I). A direct impact is noted 1, while indirect is 0.5. The absence of coefficient means there is no significant impact.

For example, practice #3 "Associated crop production" has a direct impact on environmental outcome III "Biodiversity", an indirect impact on outcome IV "Pest management" and no significant impact on the 3 others.

Table I: Agricultural practices designation, categories and their impact on the 5 environmental outcomes. *Cat: Category of the practice (A-B-C); SOIL: Soil outcome; WAT: Water outcome; BIO: Biodiversity outcome; PES: Pest management outcome; C: Carbon outcome; Impact 1: Direct impact; Impact 0,5: Indirect impact; No value: Non-significant impact - Refs: References defining the category of the practice (A,B or C). *Category depends on crop type (annual/perennial), see point VII below.*

Agricultural practices			Impact of agricultural practices on the 5 environmental outcomes					Refs
#	*Designation*	*Cat*	*I SOIL*	*II WAT*	*III BIO*	*IV PES*	*V C*	**Refs**
1	Duration of the rotation	A/B*	0,5		1	1		[26–31]
2	Number of different species grown in rotation	A	0,5		1	1		[32–34]
3	Associated crop production	C			1	0,5		[32]
4	Proportion of soil surface covered during cultivation	A	1	1	1	0,5	0,5	[35–37]
5	Incorporating intermediate cover crops into rotation for agronomic purposes	A	1	1	0,5	0,5	0,5	[36, 38–41]
6	Growing endangered plant varieties or species	C			1			[42, 43]
7	Inter-parcel agroforestry practice	A	1	0,5	1	0,5	1	[36, 44–46]
8	Intra-parcel agroforestry practice	A	1	0,5	1	0,5	1	[36, 44, 45]
9	Fallowing	B	1		1	1		[47, 48]
10	Presence of borders, grassed strips and buffer zones	B		1	1		0,5	[48–52]
11	Presence of beehives or nest boxes on the farm	C			1			[53]
12	Practices favoring melliferous species for pollinating insects and allowing flowering to be staggered throughout the year	C			1			[53]
13	Types of products used to manage weeds and pests	A	0,5	1	1	1		[33]
14	Using biocontrol solutions against pests and diseases	B		1	1	1		[54, 55]
15	Implementation of specific agronomic practices in the weed management strategy	B		1	0,5	1		[56, 57]
16	Use of precision weeding	C		0,5	0,5	1		[58, 59]
17	Use of a decision-making tool to manage weed control	C		0,5	0,5	1		[60]
18	Proportion of legumes in the rotation	A	0,5	1			1	[61–63]

19	Use of a decision-making tool to manage fertilization	C	1	1			0,5		[64]
20	Use of precision fertilization	C	1	1			0,5		[65]
21	Drawing up a nitrogen balance sheet to manage fertilization	B	1	1			0,5		[66–68]
22	Use of biological solutions to stimulate soil fertility	C	1	1	0,5		0,5		[69]
23	Use of organic fertilizers	A	1	1	0,5		1		[33, 50]
24	Crop residue management type	B	1				1		[70, 71]
25	Use of deep tillage (> 20 cm)	A/B*	1		1		1		[50, 72, 73]
26	Type of irrigation used on parcel	A		1					[74, 75]
27	Existence of a device to measure the amount of water applied to the plot	B		1					[75, 76]
28	Use of a decision-support tool to control irrigation	C		1					[76, 77]
29	Mulching the rows	B	1	1		1			[78, 79]
30	Growing drought-tolerant varieties/species	B		1					[80]
31	Evolution of irrigation water volumes brought to the plot during periods of water shortage (drought, etc.)	B		1					[77, 81]

II. *Agricultural practices assessment and scoring*

The 31 agricultural practices (Table I) are assessed through questions allowing a maximum of 3 pre-established entries (eg: Yes/No/Partially) from which a grade out of 100 is attributed (0 for the least and 100 for the most regenerative configuration) (Table II). The "agricultural practice score" is the grade weighted according to the agricultural practice category (Table I). The maximum "agricultural practice score" for a practice is therefore 400 for a category "A" (100*4), 200 for a "B" (100*2) and 100 for a "C" (100*1) (Table II).

Table II: Example of 3 Agricultural practices categories (and weight), assessment pre-established entries, grades and corresponding scores. *Agricultural practices scores are obtained by multiplying the grade by the category weight.*

Agricultural practices					
#	*Designation*	*Cat/Weight*	*Pre-established entries for assessment*	*Grade*	*Score (Grade*weight)*
16	Use of precision weeding	C/1	Yes	100	100 *(100*1)*
			No	0	0 *(0*1)*
10	Presence of borders, grassed strips and buffer zones	B/2	Yes with ecological maintenance	100	200 *(100*2)*
			Yes with intensive maintenance	50	100 *(50*2)*
			No	0	0 *(0*2)*
23	Use of organic fertilizers	A/4	Yes	100	400 *(100*4)*
			Partially	50	200 *(50*4)*
			No	0	0 *(0*4)*

III. *Assignment of the 31 agricultural practices scores to the 5 environmental outcomes*

The agricultural practices scores are assigned to each of the 5 environmental outcomes according to the relationship presented in Table I. For example, the agricultural practice #16 "Use of precision weeding" scored 100 (answer "yes", weight C/1) has an indirect impact on water and biodiversity, and therefore assigned 50 (100*0,5), while having a direct impact on pest & weed management assigned 100 (100*1). The other environmental outcomes are not considered to be related to this practice and are thus not assigned (Table III).

Table III: Examples of agricultural practices scores assigned to the 5 environmental outcomes.

The agricultural practices scores are assigned to the environmental outcomes as follow: multiplied by 1 if they have a direct impact, multiplied by 0,5 if they have an indirect impact, not assigned if they have no significant impact.

Agricultural practices				Agricultural practices scores assignment to the 5 environmental outcomes				
#	*Designation*	*Entry*	*Score*	*I* *SOIL*	*II* *WAT*	*III* *BIO*	*IV* *PES*	*V* *C*
16	Use of precision weeding	Yes	100		50 Indirect 0,5	50 Indirect 0,5	100 Direct 1	
23	Use of organic fertilizers	Yes partially	200	200 Direct 1	200 Direct 1	100 Indirect 0,5		200 Direct 1

IV.   *Environmental outcomes index calculation*

The sum of all the scores assigned to an environmental outcome according to the methodology described above (Table III), divided by the sum of all the potential maximum corresponding scores (most regenerative configuration), results in a "outcome index" (out of 100). The 5 outcome indexes are represented in a radar diagram, providing an initial level of analysis (Fig-2).

V.   *Field cultivation index calculation*

The average of the 5 environmental outcome indexes corresponds to the Field Cultivation Index (FCI), which provides information on the overall level of environmental performance of the cultural system. For example, for the crop shown in Fig-2, the FCI is 58 (out of 100) and corresponds to the average of the 5 environmental outcome values presented.
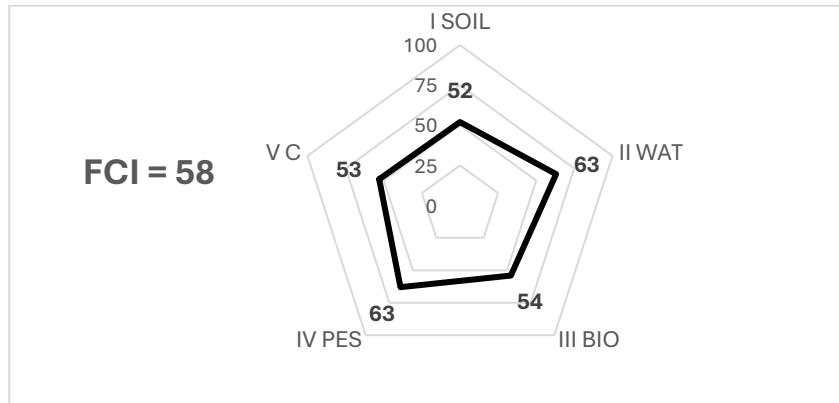
Fig-2: Example of a FCI assessment for a crop – FCI, 5 environmental outcomes index and diagram (radar). *SOIL: Soil outcome; WAT: Water outcome; BIO: Biodiversity outcome; PES: Pest management outcome; C: Carbon outcome*

To date, we consider an agricultural system to be satisfying when a threshold of 70 or more is reached. This threshold remains arbitrary at this stage and is based on the results we got from the 40 agricultural systems studied and completed by our agronomic expertise.

VI. *Practices improvement recommendations*

The FCI index is accompanied by a list of "suggested" improvement practices drawn from the assessment. Implementing such practices into the cultural system increases its regenerative nature and therefore increases the FCI score.

VII. *Methodology adaptation for annual and perennial crops*

As perennial and annual crops have specific agronomic characteristics, we adapted the methodology as below example:

Practice #1 "duration of the rotation" assesses the diversity of the agricultural system. This will be done by evaluating the duration of rotations for annual crops and the duration of intercropping for perennial crops.

Some practices are also addressed only for perennial crops, and others only for annuals. For example, practice #4 "Proportion of soil surface covered during cultivation" only concerns perennials. We are working on the assumption that only perennial plants are grown in rows, in which case inter-row coverage is a stake. Practice #5 "Incorporating intermediate cover crops into rotation for agronomic purposes" only concerns annuals, for which the frequency of intercropping is much greater.

Finally, the global impact on the environment of some practices is not the same for perennial or annual cultural systems. The agricultural practice classification (category A, B or C) therefore varies according to the crop type. For instance, Practice #1 "Duration of the rotation" will be classified A for annual systems because its impact is referenced as significant in the literature, while it will be B for perennial systems as the assessment is based on the duration of intercropping. Similarly, practice #25 "tillage" is described as having stronger impact on the soil for annual crops system (therefore classified A) than for perennial crops system grown over a decade (classified in category B).

RESULTS

- *Polyvalence and Discriminating character of FCI*

FCI assessment was made on about 40 cultural systems of 12 different crops, with diverse characteristics: 4 major climatic regions (Temperate, Mediterranean, Arid, Tropical), perennial and annual crops, certified organic or not. Fig-3 presents the results for 12 different crops produced with different cultural systems. The FCI scores are ranged from 16 to 79 showing clear discrimination between systems, and 10 cultural systems reached the to-date acceptable threshold of 70.

In these analysis, annual crops grown in temperate environments have the best FCI scores (from 74 to 79) due to the implementation of significant numbers of A practices. In average, organic farming systems also received the highest scores, but it is to be noted that "Rice A" and "White

rose A" are among the lowest-scoring systems (22 and 32 respectively), even though they are organic. Reversely, "Rapeseed C" run conventionally, has one of the highest scores (74). These results, that we see being very specific to each farming systems, will be finetuned with a larger number of future assessments.
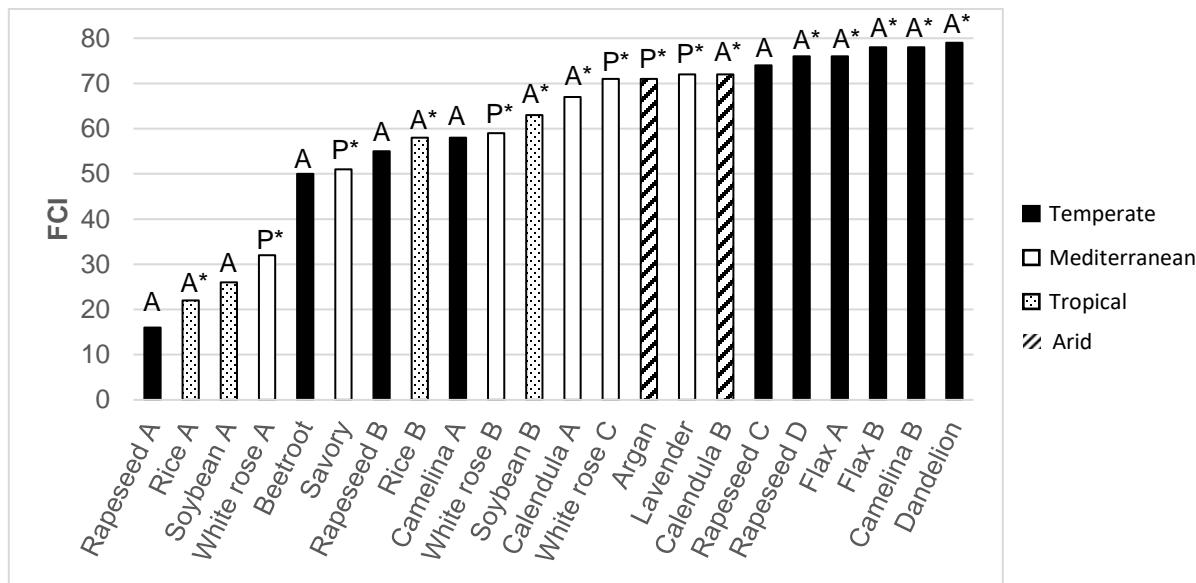

Fig-3: Main results of FCI assessments carried out. *A: Annual crop; P: Perennial crop; *: organic certification*

- *FCI is a Simple and easy-to-use tool*

FCI tool was tested with about forty producers (farmers, technicians, production site managers). Data was collected either by direct interview, or by sending out the questionnaire after a preliminary phase of methodology explanation.

At the operational level, we demonstrated it's easy to gather information. Interviews lasted an average of 30 minutes. The precision of the questions and the simple pre-established entries (answers) facilitate interviewee response based on his or her knowledge without having to refer to documents or other cultural notebooks. Also, apart from a few occasional requests for

clarification, questionnaire is filled at once. Feedback from interviewee is very positive: questions are relevant, clear and strait-to-the point with the right level of details.

- *White rose production sites comparison*

The FCI was tested on 3 white roses production sites (X, Y, Z). All are organic certified but with contrasted agricultural practices. Site X adopts a "simplified" approach with little regenerative potential: intensive soil preparation, few soil coverage and limited integration of agroecological infrastructures. In contrast, site Z, which is a demonstration plot for stakeholders, is the most advanced in terms of regenerative practices. Site Y is an intermediary between X and Z.

SITE X	SITE Y	SITE Z
FCI = 32	FCI = 59	FCI = 71
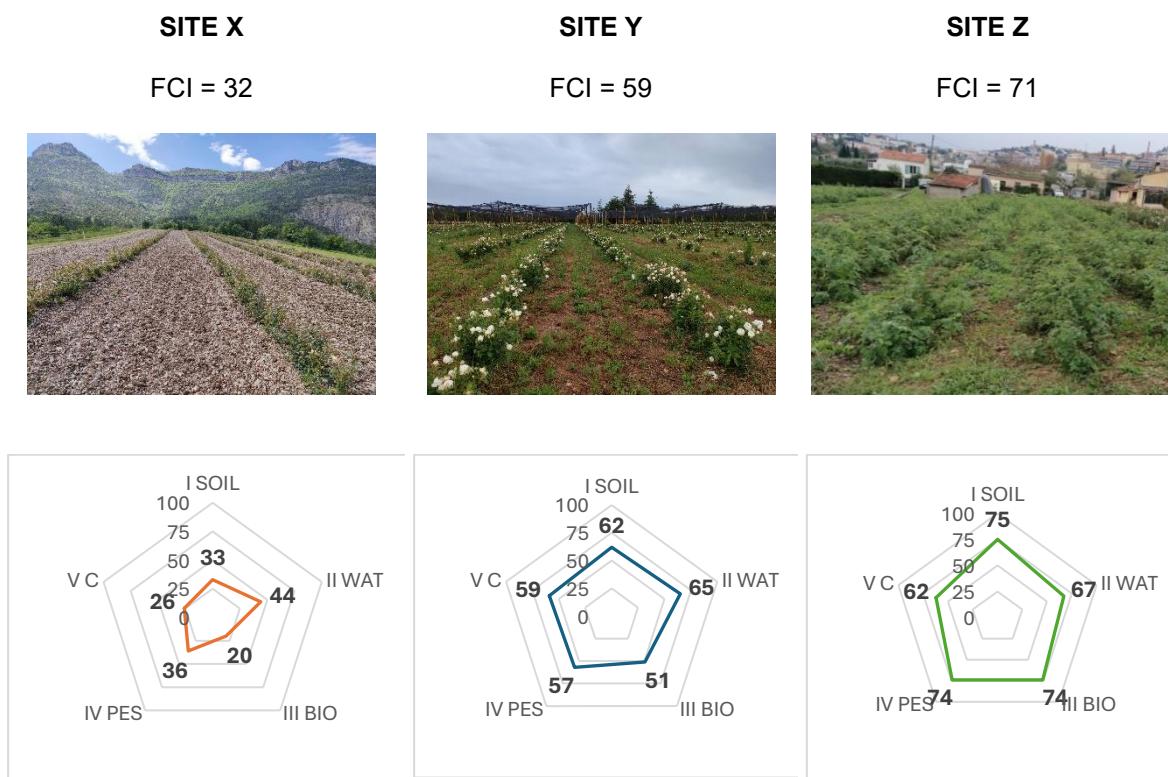
Fig-4: FCI evaluation results for 3 white rose production sites (X, Y, Z)

The FCI assessment confirms the exemplary nature of site Z (FCI=71). The organic-certified site X (FCI=32) appears to have considerable scope for improvement as its 5 environmental outcomes index are low, especially the "Biodiversity" (20) and "Carbon" (26) ones. Site Y

(FCI=59) would require improvement, especially on "biodiversity outcome" (Index=51) to reach more satisfactory score.

FCI tool suggests a bunch of practices to be deployed on site X and Y to engage the regeneration process. Table IV summarizes the most impactful and easily deployable ones (non-exhaustive list) since they are implemented at sites Z.

Table IV: Suggested most impactful agricultural practices to implement on white roses production sites X & Y. *All the practices listed below are already implemented on the site Z. Grey box = recommended practices (not exhaustive)*

	Agricultural practices recommendation	Production sites	
#	*Description*	X	Y
2	Integrate 5 additional plant species in the cultural system	■	
2	Integrate 2 additional plant species in the cultural system		■
4	Increase the proportion of soil surface covered during cultivation	■	
18	Include legumes in the cultural system (for example as cover crop)	■	
1	Extend the interculture duration (period between 2 plantings) by 2 years	■	■
7	Developing inter-parcel agroforestry	■	■

- *Rapeseed production sites comparison*

FCI was tested on 21 rapeseed production sites. With many 'A', 'B' and 'C' category practices, the S21 system scored FCI=74, demonstrates it is possible to achieve a satisfactory score above 70 while other systems are scored between 19 to 49. For example, there are no 'A' category

practices deployed in systems scored <30, while several are implemented in systems scored >40. It may provide inspiration for the less advanced systems, which, by introducing a few 'A' practices, could increase their environmental performance without involving radical changes (e.g. include additional species and cover crops in the rotation, plant hedges around plots, …). Although this would not lead to the satisfactory score of 70, it would be a first step towards improving the performance of the given cultural system.
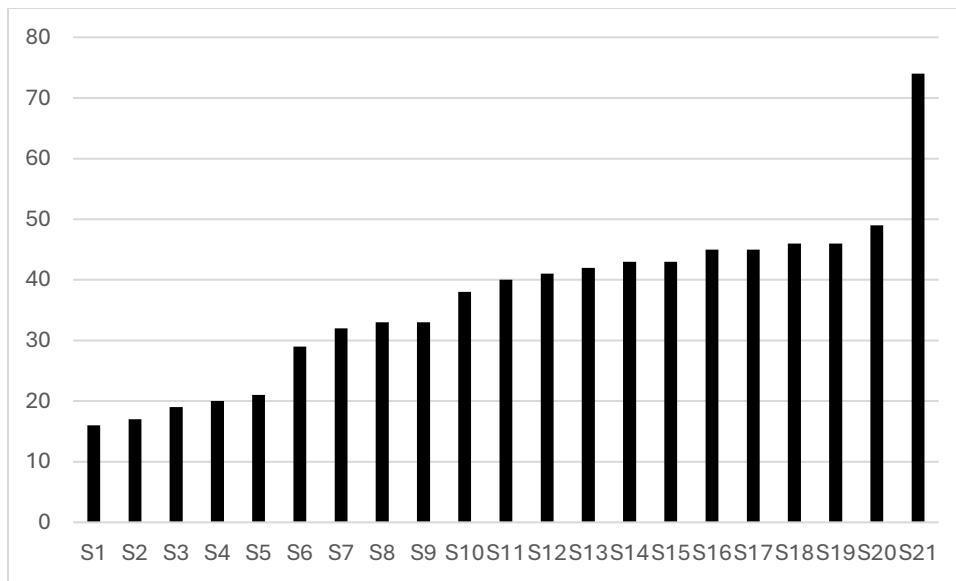

Fig-5: FCI scores from the evaluation of 21 different production systems for an annual crop in a temperate climate

DISCUSSION

The tests carried out highlighted the following points:

- The results of the testing phase confirm FCI's objectives: 1. Do a qualitative assessment of cultural systems and identify their strengths and weaknesses to guide towards regenerative practices; 2. compare cultural systems of a given crop and identify the most environmentally performing. In particular, the FCI can discriminate cropping systems performance based on the practices that are deployed and low scores obtained by some of the organic certified systems demonstrate the high level of ambition set by the FCI. The ability of FCI to provide a list of recommended practices appears to be an asset for

improving the cultural system. The case of the white rose shows the enhanced value of these recommendations when comparing production systems for the same species.

- The testing phase also confirms that first users were predominantly interested by the FCI methodology and considered it easy to implement, collaborative, rewarding and not intrusive. The information was collected by a limited number of interviewers having enough expertise in regenerative agriculture to guide farmer's interviews. This ensured the consistency and coherence of the results. Before deploying the method more broadly, drawing up a user guide will be a prerequisite to limit the bias generated by the diversity and multiplicity of interviewers.

- Last, we confirm that, to date the 70 satisfactory threshold value seems appropriate and in line with observations made in the field. Further evaluation in different contexts, eg on sites with recognized certifications (organic, ROC, Regenagri, etc.) will enable us to refine the calibration.

Now we must acknowledge the limitation of the method:

- Although the FCI methodology is based on a holistic vision of a production system, it is limited to a single plant production system. For example, livestock farming or integration of the cultural system into the local area or landscape are not considered in current FCI assessment. If the aim is to steer the development of the agricultural production system at this level, then such additional elements should be complemented by using other tools.

- FCI does not integrate social aspects of farming practices, therefore it is recommended to complement with specific and adapted evaluation methods to offer a global vision on all aspects of sustainability. For instance, L'Oréal is implementing internal methodology based on recognized standards, scoring social aspects of a global supply chain from 1 to 4. FCI is therefore complemented by this social score.

- Finally, FCI remains a qualitative assessment tool based on resource indicators. While this approach makes the tool highly operational, it has two important limitations. Firstly, a qualitative approach using a limited list of pre-established entries (for example: "presence", "partial presence", "absence") can be imprecise for assessing the importance of some practices. As most of the practices studied are applied at plot level, the loss of precision induced by this approach seems limited. Secondly, even if supported by the bibliography, the presence of resources does not necessarily imply the achievement of results. Therefore, FCI will be supplemented by quantitative measurements to confirm the positive impact of the resources deployed. For example, through specific soil, water and biodiversity measurement to correlate efforts made over time with quantitative results and impacts.

- The FCI evaluates 31 agricultural practices valid for all contexts. These practices have been selected on their relevance to regenerative agriculture based on a review of the literature. However, in some specific contexts, the deployment of a recommended practice may not improve the performance of the cultural system or may be practically unrealistic. The aim is not to systematically implement all 31 practices assessed, reason why the satisfactory threshold is set at 70 and not 100. Rather, the approach consists of identifying the optimum combination that meets the sustainability challenges and the specific context (soil and climate, resources, etc.) of each specific cultural system and the recommendation should be considered for guidance and need to be tested against the expertise of those working in the field.

CONCLUSION

Industries exploiting bioresources are increasingly exposed to agricultural stakes. To meet these challenges, they need tools to analyze, evaluate and design production systems that are as little environment impact as possible. The Field Cultivation Index (FCI) is a relevant method that

stands out from existing tools by responding to the specific context and variety of agricultural systems used for cosmetics bioresources production. It is built around a theoretical framework embodying the concepts of regenerative agriculture, enabling the qualitative assessment of the impact of cropping systems on the 5 main regenerative environmental outcomes: soil, water, biodiversity, pesticide reduction and carbon emission mitigation. Furthermore, it helps addressing the weakness levelled so far at regenerative agriculture, which did not yet have reliable means of situating itself on progress trajectories depending on production contexts [10]. Tests carried out on about forty cropping systems in a variety of contexts have shown that the FCI is:

- Appropriate: in line with its ambition, it values the most performing cropping systems with regard to the 5 environmental outcomes.

- Sensitive: capable of discriminating cropping systems according to their level of performance.

- Demanding: reaching the satisfaction threshold 70 is requesting a high level of regenerative practices deployment.

- Operational: information is quick and easy to collect.

- Educational: results are easy to understand and interpret, even by novice users.

FCI gives farmers in any country, the opportunity to assess the environmental profile of their cropping systems based on a common benchmark, to identify ways of improving and to promote the sustainable practices that have been deployed. For bioresource procurement, it offers a solution for comparing suppliers and assessing the overall impact of a supply chain.

Through this work, we demonstrate that developing sustainable cosmetic products is a real challenge for the industry It is a global approach which not only requires new research projects in "classic" areas of expertise such as formulation or the search for new ingredients, but also in completely new fields such as sustainable agriculture and its ambition to regenerate the capacities of agroecosystems. This means new challenges for the cosmetics industry, which

must also find the resources to develop new assessment tools. For the first time we propose a new evaluation tool, FCI, that represents an excellent lever for driving forward the development of these concepts. To continue in this direction, scientists and professionals in the agricultural industry are invited to continuously use and optimize methods and tools for assessing and improving the performance of agricultural production. FCI is one of them.

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CONFLICT OF INTEREST STATEMENT

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