



ESSAY



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## Agronomic education: a systemic perspective<sup>1</sup>

*La formación agronómica: una perspectiva sistémica*

Formação agronômica: uma perspectiva sistêmica


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### KEYWORDS

integrality, holism,  
transdisciplinary,  
complexity, system.

**ABSTRACT. Objective.** To approach higher agricultural education as a complex structure, explained by the functional relationships between the formative and the executive, under performance contexts that nestle in uncertainty and chaos. **Method.** The systemic alternative is proposed as a way to reach new rationalities about what higher agricultural education, agronomic training and its professional configuration should be, through a critical and reflexive approach to its professional practices. **Results.** The guidelines of a new perspective of educational training based on epistemic and theoretical-conceptual schemes, oriented from the complexity of systems, are postulated. **Conclusions.** Professional practices represent the pinnacle of all disciplinary training, which in the case of the agricultural engineer is manifested through the ways in which he understands the social reality to intervene in it. This dialectical exercise has been pigeonholed in the postulates that science demands, under analytical, linear and predictive schemes. Such approaches to reality have

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conditioned a paradigmatic paralysis that only allows thinking in conventional forms of academic and professional training, which must be overcome by means of a systemic foundation.

#### PALABRAS CLAVE

integralidad, holismo, transdisciplina, complejidad, sistema.

**RESUMEN. Objetivo.** Abordar la educación agrícola superior como una estructura compleja, que se explica por las relaciones funcionales entre lo formativo y lo ejecutivo, bajo contextos de actuación que anidan en la incertidumbre y el caos. **Método.** Se plantea la alternativa sistémica como una vía para alcanzar nuevas racionalidades en torno a lo que debe ser la educación agrícola superior, la formación agronómica y su configuración profesional, mediante el abordaje crítico y reflexivo de sus prácticas profesionales. **Resultados.** Se postulan las directrices de una nueva perspectiva de formación educativa basada en esquemas epistémicos y teórico-conceptuales, orientados desde la complejidad de los sistemas. **Conclusiones.** Las prácticas profesionales representan el pináculo de toda formación disciplinar, que en el caso del ingeniero agrónomo se manifiestan a través de las formas en que entiende la realidad social para intervenir en ella. Ejercicio dialéctico que ha sido encasillado en los postulados que la ciencia exige, bajo esquemas de corte analítico, lineal y predictivo. Tales acercamientos con la realidad han condicionado una parálisis paradigmática que solo permite pensar en formas convencionales de formación académica y profesional, lo cual debe ser superado mediante un fundamento sistémico.

#### PALAVRAS-CHAVE

integralidade, holismo, transdisciplinaridade, complexidade, sistema.

**RESUMO. Objetivo.** Abordar o ensino superior agrícola como uma estrutura complexa, explicada pelas relações funcionais entre o formador e o executivo, sob contextos de ação que se aninham na incerteza e no caos. **Método.** A alternativa sistémica é proposta como uma forma de alcançar novas racionalidades sobre o que o ensino superior agrícola, a formação agronômica e a sua configuração profissional devem ser, através de uma abordagem crítica e reflexiva das suas práticas profissionais. **Resultados.** As orientações de uma nova perspectiva de formação educacional baseada em esquemas epistémicos e teórico-conceituais, orientados a partir da complexidade dos sistemas, são postuladas. **Conclusões.** As práticas profissionais representam o auge de toda a formação disciplinar, que no caso do engenheiro agrícola se manifesta através das formas como entende a realidade social a fim de intervir na mesma. Este exercício dialético tem sido feito nos postulados que a ciência exige, sob esquemas analíticos, lineares e preditivos. Tais abordagens da realidade condicionaram uma paralisia paradigmática que só nos permite pensar nas formas convencionais de formação acadêmica e profissional, que devem ser ultrapassadas por meio de uma base sistémica.

## 1. INTRODUCTION

Under the disciplinary gaze with which higher agricultural education has been configured in Western societies, stigmatized by positivist thinking, functional and pragmatic (see ECLAC, 2021), with clear ethical biases oriented towards extractive production processes, rational exploitation of nature —understood as a resource— and the mercantilist conception of the environment —assumed as a medium—, is that the active role it has played in achieving the current planetary crisis can be explained (Martínez-Castillo, 2005; Giraldo-Díaz and Nieto-Gómez, 2015; Andrade, 2016), either directly or indirectly (Segrelles, 2001).

The intense emission of greenhouse gases derived from the livestock industry —mainly CO<sub>2</sub> and CH<sub>4</sub>— (FAO, 2022)<sup>4</sup> and the excessive use of natural inputs (UTEM, 2020)<sup>5</sup>, added to the loss of biodiversity —native flora and fauna— produced due to the incorporation of new areas —soils— to agricultural activities, as well as the excessive use of water for irrigation and the establishment of monocultures of commercial interest —many of

<sup>4</sup> According to the FAO (2022), cattle producing meat and milk are the largest emitter of greenhouse gases (around 5.0 gigatons of CO<sub>2</sub>-eq, which represent 62% of total emissions). Pigs, poultry, buffalo and small ruminants, although they have lower emission levels, represent between 7% and 11% of total emissions.

<sup>5</sup> According to the FAO, cited by the UTEM (2020), to produce a kilo of beef, 15,000 liters of water are needed, for lamb 8,700 liters, and for pork 6,000.

them transgenic, with loss of native germplasm—, turn the professional practices of agronomists are constant referents of environmental deterioration (Villarruel-Fuentes, 2018). The incorporation of high technology as a guarantor of intensive production processes exacerbates this condition by promoting greater use of fossil energy sources —gas, oil, diesel, and gasoline, among others—. The professional stigma of producing to feed the growing world population (Bula, 2020) shows its most negative side.

But as in any professional exercise, the dominant practices come from two possible paths: educational training and work expertise, both repositories of a wealth of knowledge and experiences that are recreated under modeling processes that are repeated over and over again in time and space. The slogan of converting the novice agronomy professional into an expert executor of interventions agreed upon as necessary within the guild —socially accepted practices—determines the curricular framework deployed within the academic programs of higher education institutions. Training by competencies is the best example of this methodological statute (Parra, 2003; Civeira, 2013; Ramos et al., 2020), which is usually accompanied by a semantic matrix and linguistic codes that are specific to agronomic knowledge; production, productivity, effectiveness, efficiency, performance, exploitation, quality, among others. The circularity of thought, typical of agronomic language —the ontology of language—finds its limits in the words it uses to express itself.

For this reason, it is essential "to draw attention to the need to formally and collegially articulate the constitutive bases of a new branch of the philosophy of life sciences, the philosophy of agronomy" (Serrano-Bosquet and Rivas-Sada, 2014, p. 176), for which it is unavoidable to start from detonating, challenging ideas, which lay the "initial bases on which this genitive philosophy can be built" (Serrano-Bosquet & Rivas-Sada, 2014, p.176).

But the agronomic profession will have to find in its new purposes the seed of change. Unforeseen, even unwanted transformation that, although necessary, is not being promoted from the "hard" core of the profession. The evolution of environmental knowledge, considering respect for nature; the change from the Cartesian paradigm to an integral and holistic one; the irruption of the concept of sustainability and its decline through the meaning of forms and not only through means; but above all, the systemic perspective that pays to the complexity of the phenomena far from its linearity and prediction, are a clear invitation to resignify the profession, which entails proposing new discursive logics, new legal principles, where verbal and written constructions are less nominal and more personal, and thus more active. The latter is in contrast to the so-called «language of science.»

## 2. ESSAY'S BODY

### Tradition versus the systemic in agronomy

What is the idea behind this transformation? The principle is basic: the paradigm shift can only be achieved through language. It is quite evident that nineteenth-century science imposed on many fields of knowledge, including agronomy, the imprint of its impersonality, its cult of objectification, factual validation and empirical testing, under criteria of experimentation sustained by control and manipulation of the phenomena under study. In no other area does this conceptual and methodological catechism operate as firmly as in the agricultural sciences. Since Francis Galton and Karl Pearson, but especially Ronald Aylmer Fisher (Infante-Gil, 2007), every inquiry process is governed by the discovery of objective —numerical— truth and not by its construction. Experimentation, in its purest form, is a constant in studies that determines agronomic knowledge, its theoretical corpus.

On this basis, a linguistic universe was built, limited to the logic of a body of knowledge in which "the semantic extension of the noun is delimited and specified" (Llácer-Lorca and Ballesteros-Roselló, 2012, p.53), ideological neutrality that understands the universe of interest as something other than the observer.

Based on absolute certainties, assumed as categorical imperatives, agronomy lays its traditional disciplinary foundations on the current state of societies, a situation that comes into contradiction when observing current problems, not only in food production processes —mission and substantive vision of the profession—, but particularly in those dimensions and categories surrogate to it, such as malnutrition associated with poverty, enlightened illiteracy derived from low educational level, additions, mass migration and the abandonment of rural areas due to violence, the increase in the price of agricultural and livestock inputs as a result of an unstable economy, among other epiphenomena that mark the course observable in the labor dynamics of the agronomy professional.

Although these social conditions are not new in Latin America —particularly in Mexico—they do represent a new socio-educational challenge, which in the first instance, must be reflected in new curricular frameworks within higher education, where the ideology of a new agronomist is projected. , now under interdisciplinary and transdisciplinary perspectives, guided by systemic approaches, which become visible and operable within the official —institutional— grids, particularly in the didactic approach of teachers who teach agronomy.

This demand calls for the integration of models that transcend the current "systemic approaches to rural development" (Borneman, 1998), largely focused on property, production, and the peasantry, based on empirical reference frameworks, which address the components of a system from its macro and micro dimensions, but without overcoming the reductionism that the analysis of said units implies, which parameterizes its functional relationships in search of universal constants of external validity. Suffice it to remember that "Analytical methods remain valid, but they do not record the connections within and between systems and subsystems" (Loewy, 2021, p.85).

These approaches consider the economic dimension as the articulating axis of the system, its detonating nucleus<sup>6</sup>, which makes it an invariable, which among other things prevents observing the true complexity of the system.

Based on this, "zoning" and "typifying" within agronomy lead to determining the production models operating in a given space and time, giving rise to typologies that delimit all reality and any phenomenon, which excludes cultural components—previously indicated. Thinking about the reality of phenomena from their integration by variables is a condition that invokes linearity and the sense of cause and effect. Understanding how to modify this approach is not easy since even those who propose a systemic approach often find themselves in contradictions. As an example, we can cite what was pointed out by Loewy himself (2021), who establishes that "In systems theory, the social, the economic or the ecosystem become new subjects of analysis" (p.88). This demonstrates the paradigmatic paralysis that underlies the disciplinary vision, which feeds on the nineteenth-century scientific paradigm of a Newtonian nature, and which makes its effects felt even by those who intend to change.

Special mention deserves the efforts to appropriate the concept of sustainability, or sustainability, and take it to the theoretical and epistemic field of agronomy. Efforts in this direction have been focused on the conceptual

<sup>6</sup> Conceived as a totipotential disciplinary field.

area of agroecology, more specifically agroecosystems, with all possible variants —clean technologies, ecological and backyard farming, agro and silvopastoral systems, and organic farming, among others— understanding them as efforts to transform properties where commercial, extractive and polluting agriculture is developed, taking them to the field of "good agricultural practices". From these interventions, there is talk of possible sustainability, evident through indicators that demonstrate its palliative effect. There are no references that indicate how to make sustainability possible from new professional practices, which initially appropriated their foundations. For this reason, it is stated that "Incorporating equity in rural environments is inextricably associated with the production scale" (Loewy, p.90), that is: with the production unit.

This is the epistemic reality of agronomy and its professional practices. Traditionalism has provided criteria and senses of identity and belonging in a widely documented historical evolution. However, if, as Casanova-Pérez et al. (2015) agroecology is the repository of the philosophical and theoretical perspective of complex systems, broken down through interdisciplinary, where the agroecosystem is perceived as an organized whole, it is necessary to determine the components of its structure, especially the relationships established between them since there nests its degree of complexity, its resilient capacity and its autopoietic potential. But where does the globalizing entity of said structure lie? In the social, as Luhmann (2006) assures? Economically, politically, or educationally? Is it ecological? The answer will then be subject to the postures or worldviews of the observer, who, from his point of view, defines what the system is, a condition that emphasizes a relevant factor: culture.

### **Culture and communication: the possible way**

By accepting that human perspectives and representations —individual and social— are the building axis of the system, of its functional structure, then it is easy to notice the effect that this has on the reality that is said to be known. The criteria of truth take on a relative, intersubjective value, of a phenomenological and hermeneutical nature, based on a set of values, beliefs, and knowledge, which do not always derive or tend from Cartesian scientific thought —the most dominant within agronomy—. Culture, so historically relegated by scientific disciplinary thinking, typical of the Eurocentric tradition, is redefined by the possibility of systematically undertaking the study of agronomy and its professional applications, now conceived as a complex system.

The opportunity to place each component of its structure on the same hierarchical level —biological, social, political, economic, among others— supposes thinking of the system as a «cultural arrangement,» recovering the double meaning that it constantly had as its origin: agri-culture<sup>7</sup>. To project from there towards the broadest and most inclusive sense of the system: agronomy. Under these precepts it is possible to affirm that agronomy is, before anything else, culture<sup>8</sup>.

Derived from this, agronomy, in its capacity as recipient of social aspirations and global commitments, attached to the scientific and technological trends of the new century, can only be explained in its concretion from its

<sup>7</sup> In Giraldo's concepts (2013) "To understand the ontology of agriculture, the very being of the work that human beings do, it is necessary to understand the original and etymological meaning of the word" (p.3). In this case, "the term agriculture is made up of two Latin derivations: Agri- from agri, which expresses 'art of cultivating the field', and -Culture, from the verb Colere, whose original root means 'to cultivate' and 'to inhabit'" (p.3), which determines that the meaning of the word Agri-Culture is the art of cultivating and inhabiting the land.

<sup>8</sup> It is about recovering the relationship that nature has always had with culture, regardless of whether one depends on or determines the other —two models differentiated over time—; In any case, there is an interrelation between both dimensions (González-Jácome, 2003), to the extent that they are currently forming a single entity, a single system.

institutionalization<sup>9</sup>. This reduces the spectrum of their learning to school settings, where it takes discursive form in the precepts that science itself imposes, aligning it with the premises of an ecumenical language, which recreates for all, the duty of the agricultural engineer. It is a school science that dictates guidelines for technical thought, thus reducing the semantic universe of the agronomy professional.

This explains how concepts such as sustainability, progress, life, environment, and nature, among others, are specifically interpreted within the agronomic language, turning them into linguistic codes that can only be decoded by an agronomist. The possibility of finding in other areas of human knowledge new ideological signifiers that nourish agronomic thought is canceled. This generates voluntary isolation by not finding communicating bridges that bring their identity knowledge closer to that which is typical of anthropology, sociology, psychology, and education, among many others. Their absence within the curricular guidelines of agronomy models and programs is not fortuitous. It is intentional, perceiving that they are not necessary to practice professionally.

The professional dynamics of the agronomist make this condition clear. The design of what some call the "new agronomic profile" is plagued by efficiency rhetoric, as can be seen in the published literature (see Duarte et al. 2011; Córdova and Barbosa, 2004; Nieto-Caraveo and Díaz-Villa, 2021) . The recursion of language cancels possible futures since, according to Sístek (2018), the human experience shows an "equally circular complementarity between making sense and constructing meaning" (p.1).

For example, we can cite the new task of making agronomy something sustainable, a condition that, for the agronomist, is achieved by transforming agricultural production systems through the construction of environmental and economic sustainability indicators and, to a lesser extent, social ones. As well as defining sustainability indices, "synthesizing values of economic, environmental, and social indicators in a single numerical value" (Pinedo-Taco et al., 2021, p.2). Others choose to develop "conceptual evaluation frameworks with a hierarchical structure of indicators" (Pinedo-Taco et al., 2021, p.2), starting from attributes or objectives and patents through comparison.

This definition, closely attached to the professional idiosyncrasy of the agronomist, agrees with the meaning that is coined from here; inappropriate if observed from references such as biology or ecology, and even from agroecology itself—to place it in its own primary environment—. This alludes to its most practical—technical—sense, ignoring the referents of culture—community, territory, history, traditions, education, and long, etcetera— mentioned above. In this way, the adjectives of succumbing to morphological substantiation through the use of «determinants» that accompany the noun to determine it and provide information about it. This seems to be the fate of sustainability.

### Education as a system

Thinking about higher agricultural education in its systemic character—agronomy as a space for cognitive, axiological, and procedural construction, where knowledge, skills, attitudes, and experiences converge and interact— requires at least three conducive actions: 1) define its epistemic field<sup>10</sup>, that is, its ontological and

<sup>9</sup> Agronomy, being considered a priority issue, including national security, is under the stewardship of the States. National project whose guidelines are made clear in higher agricultural education institutions.

<sup>10</sup> Serrano-Bosquet y Rivas-Sada (2014) ponen en relieve la necesidad de acuñar una filosofía propia de la agronomía, para lo cual establecen la necesidad de "una filosofía de la agronomía, que dé cuenta de los fenómenos específicos de esta disciplina, a la vez que

teleological sense; 2) identify the components of its structure; and 3) define its “stable state”, according to the context of action. In these cases, it is essential to clarify the object of study of agronomic education, freeing it from the stigma of production, biological processes and the effective use of science and technology as inherited purposes and destinations, a fact that leads to venturing into more sociocultural, seeking to expand its structural network, giving it new meanings. This condition leads to proposing new functional relationships —interactions, with which the complexity of the system tends to be greater, since it will involve emotional, psychic, psychological, sociological, and even spiritual aspects, and not only cognitive and methodological —technical, understanding that education is a set of collective facts and circumstances —community—, culturally determined.

From these margins, which aspire to move from the periphery to the center, the sociological theory of systems emerges as an alternative to move from the autopoiesis of biological systems to the self-organization of social systems, which means abandoning the idea of a metabiology that applied to agronomic education can explain and interpret it. The implications that this entails are important, since it will allow moving from the theory of action to the theory of communication (Leydesdorff, 2000). According to Leydesdorff (2000), social systems enable communication about observations from within the system, or from another perspective. This new condition should favor the critical sense that is needed to achieve sustainability within the agronomic profession, becoming a feasible path for its transformation.

These linguistic performances expressed in communication —in a Chomskian sense, but without losing their quality as a system<sup>11</sup>— they would transform the ways and means of understanding agronomic intervention practices, leading the agronomy professional to distinguish between what is uncertain and what is significant. Epistemic, theoretical and conceptual clarity that would be adequately codified for its transmission and decoding. The possibility of arranging and organizing new linguistic structures is a first step in the right direction in search of achieving the necessary transdisciplinary.

Following Luhmann (1986), from these instances, it is feasible to distinguish —and incorporate— in the autopoietic organization the triple systemic connotation: life, consciousness, and communication. For the latter case, it is assumed that "communications trigger more communications and perform the autopoiesis of social systems" (Vanderstraeten, 2000, p.581). The construction of new linguistic codes and the configuration of renewed semantic matrices must allow the transition from school life to professional life without undermining its basic cultural productions. Education - educational model, curricular frameworks, curricular design, didactic instrumentation, as a whole - will no longer be seen as a subsystem, typical of the educational system, but as "a system that adopts a structure determined by its interaction with other systems, with which maintains a permanent and productive interaction" (Gómez-Dacal, 1981, p.7), always dynamic and in permanent evolution, "whose configuration decisively influences a mechanism of permanent adjustment to its environment, to its demands and requirements" (Gómez-Dacal, 1981, p.7).

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proponer algunos principios que, como ideas detonadoras, funjan como bases iniciales sobre las que pueda levantarse esta filosofía" (p.175), aunque para ello es necesario trascender los enfoques disciplinarios.

<sup>11</sup> Es necesario un distanciamiento con el concepto de competencia lingüística propuesta por Chomsky, donde desde una perspectiva biolingüística propone la idea de un oyente-hablante idealizado, que asocia sonidos y significados sobre reglas inconscientes y automáticas (Barón-Birchenall, 2014). La actuación lingüística incorpora elementos extralingüísticos, como por ejemplo las creencias.

However, this mechanism should not be confused. The school is not a system that depends exclusively on the environment. Although it adapts to it by self-adjusting, the environment also adapts according to the components and relationships of the school itself, which must be used in favor of the desired transformations.

In this regard, it is necessary to emphasize that the very resilience of the environment —political, social, economic, and biological/productive— has not allowed the structure of the school system to be modified. Since the same components are always the ones that make up the system, with predicted and sustained relationships in time and space, its alignment between systems —educational and contextual— has generated a "functional paralysis" where all change is transitory, never permanent.

The initiative to incorporate new components within the school system —parents, community, territory, leaders, educational models, high technology, and scientific innovations, among others— has succumbed to this resilience, returning the system to its original state in search of match the structure of the environment. The same has happened in the opposite direction. The result: the maintenance of a paralyzed and paralyzing macrosystem, always disciplinary.

It is necessary to understand that education is a system, not a process. In any case, the processes are what make the interrelationships between its components possible. Disrupting its structure must lead to generating new dynamics, but for this, the system must be opened to new scenarios of thought and action.

Such shaking can be conceived as an "induced entropic state" (Cárdenas-Messa, 2020), where an established order passes to one where chaos and uncertainty nest. Said entropy will serve as a counterweight to the already mentioned resilient capacity of the system, which from the resistance to change, is shown by the human component in the two systems —educational and contextual/professional—. Cárdenas-Messa (2020) identifies two observable positions in said component: the Kinetics of Rooting, characterized by the support of the forms and means of educating, seeking to maintain their states of comfort and privilege; and Pedagogical Activism, represented by simulation, that is, by pretending that a change is accepted, only to hide the same practices, whether educational or labor. At the educational level, there is talk of a "didactic statism with theoretical mobility" (Cárdenas-Messa, 2020, p.3), which on many occasions is also expressed in honest efforts to understand and incorporate innovations, but without success, since that, it is unknown how, when and where to do it, but above all why.

### 3. CONCLUSIONS

In 2007, the McKinsey report established that the success of educational systems is due to three factors, all associated with teachers, their training, and the institution itself. What is remarkable is that in its executive summary it is established that these systems demonstrate that the best practices to achieve these three objectives are not related to the culture of the place where they are applied. They also assert that this can achieve better results in the short term, and that the universal application of these practices can have an enormous impact in improving educational systems that present difficulties, wherever they are. It is a functional, efficientist rhetoric, which dictates behavior canons, closely linked to the labor dynamics of a commercial, economic structure —environment—, which in the case of agronomic education and its professional practice is evident in its dominant practices and substitutes for the profession itself.

This exemplifies the rigidity of its structure, the ordering between systems, and the invariability of the relationships between its components. Condition that must change, since there is the "notion of a changing



world, subject to chance, to uncertainty, which is not represented in a static educational system, with a lot of theoretical mobility, but little didactic and evaluative mobility." (Cárdenas-Messa, 2020, p.1).

This is where the entropic principle becomes relevant. Thinking about entropy can seem like a drastic exercise in transformation. However, the rigidity discussed above is nothing more than a stable state of the systems — low level of entropy—, which must be disrupted to promote a reorganization of these systems<sup>12</sup>. Although reaching the desired negentropy —negative entropy— already with the required modifications, includes a component of chance, which is likely to be present in social systems, since there are many disruptive factors, it is expected to be less in cultural ones. To this extent, generating educational scenarios to promote entropy — starting with school spaces—, becomes a sine qua non condition of the transformations required in agronomic education, in search of responding to the needs of a dynamic professional reality<sup>13</sup>.

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Los autores declaran que no incurren en conflictos de intereses.

#### **Rol de los autores / Authors Roles:**

Manuel Villarruel-Fuentes: Conceptualización, curación de datos, análisis formal, investigación, metodología, recursos, software, supervisión, validación, visualización, administración del proyecto, escritura -preparación del borrador original, escritura -revisar & edición.

Rómulo Chávez-Morales: Conceptualización, análisis formal, investigación, metodología, administración del proyecto, escritura -preparación del borrador original, escritura -revisar & edición.

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<sup>12</sup> If the system is disrupted, it is unlikely that it will return to its original state; however, the entropic principle establishes that said system always evolves to its most probable state, where it has more microstates —with the same probability of occurrence— and therefore more entropy. Of course, everything is explained by processes that are irreversible, in this case the high probability of a deontological change in the agronomic education/profession.

<sup>13</sup> Although entropy is understood as the natural tendency to lose order —balance— in the system, the idea is to generate a macrostate within the system, where the multiplicity of combinations does not give the same result —as is typical of this law—. This necessarily involves modifying the resilience of the prevailing educational cultural system in agronomic training, already discussed in this article, as a way to achieve change in professional practice results.

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