Exploring Vitality in Sustainable Agriculture
The Effectiveness of a Multi-Method Approach on Strawberry Crop Systems

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EXPLORING VITALITY IN SUSTAINABLE AGRICULTURE: THE EFFECTIVINESS OF A MULTI-METHOD APPROACH ON STRAWBERRY CROP SYSTEMS

Lages, BR

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Thesis presented to the Post Graduation Programs in Plant Sciences at the Santa Catarina State University and Interdisciplinary Studies in Agroecology, Water and Resilience at Coventry University as a partial requirement for obtaining the Doctorate (PhD) double degree award, in Plant Sciences and Interdisciplinary Studies in Agroecology, Water and Resilience.

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Certificate of Ethical Approval

Applicant:

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homeopathy and biodynamic: understanding challenges & identifying innovations in agriculture.

This is to certify that the above named applicant has completed the Coventry University Ethical Approval process and their project has been confirmed and approved as Medium Risk

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Viva, on the 19th of October de 2022.

To the primordial consciousness

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RESUMO

Agricultura é uma das mais essenciais atividades para o desenvolvimento da humanidade. No entanto, as práticas dominantes empregadas na agricultura hoje são derivadas da ontologia cartesiana e mecanicista. Esta abordagem de agricultura acabou por ameaçar os meios de subsistência dos agricultores e a segurança alimentar em geral. Tais praticas tiveram efeitos deletérios sobre os ecossistemas, reduzindo significativamente a biodiversidade, contaminando o solo, água e alimentos com fertilizantes solúveis e pesticidas. Em contraste a agroecologia oferece um modelo holístico de agricultura baseado em interações de biodiversidade e sociedade, de métodos que estimulam a homeostase dos ecossistemas e uso de produtos menos tóxicos para eliminar a dependência do sistema alimentar no uso pesticidas e fertilizantes solúveis não renováveis. Esse estudo analisa o potencial de uso do método agroecológico da Homeopatia e das altas diluições dinamizadas (DHDs) na agricultura, investigando seu efeito de bio-estimulador em plantas e sua contribuição no desenvolvimento de sistemas agrícolas sustentáveis. Esse estudo explora através de uma abordagem multidisciplinar como a compreensão da vitalidade do agroecossistema pode contribuir para o desenvolvimento de estratégias de práticas e pesquisa agrícolas em direção à sustentabilidade. A tese é apresentada em 6 capítulos. Capítulo 1: Introdução geral a tese; Capítulo 2: A revisão sistemática identifica e agrupa dados sobre vitalidade na pesquisa agrícola nos últimos 20 anos; Capítulo 3: Apresenta os resultados dos experimentos agronômicos de dois anos testando DHDs e seu efeito bio-estimulador em plantas de morango (*Fragaria* × *ananassa*); Capítulo 4: Apresenta e explora os dados do questionário respondido por agricultores que usam Homeopatia e DHDs na agricultura, examinando o impacto que o método tem nas práticas agrícolas e na promoção da vitalidade do agroecositema; Capítulo 5: Discuta e apresenta os resultados de entrevistas feitas com pesquisadores, consultores e agricultores internacionais que trabalham com Homeopatia e altas diluições dinamizadas (DHDs) como forma de promover a vitalidade do agroecossistema. Capítulo 6: Conclusão geral da tese. A revisão sistemática identificou 21 termos científicos que abordam a vitalidade na pesquisa agrícola, verificou um aumento de 79,72% no número de publicações relacionadas ao tópico desde 2017. Destacaram-se China, Índia, França, Alemanha, Polônia e Brasil como os países com múltiplas publicações sobre o tema. Os resultados dos experimentos agronômicos testando o potencial bio-estimulador de DHDs na cultura de *Fragaria* × *ananassa*,

mostraram que as altas diluições dinamizadas (DHDs) minerais estimularam a produção, o crescimento e o desenvolvimento das plantas de morango. O questionário revelou que os agricultores utilizam homeopatia e DHDs por perceberam melhorias na qualidade das colheitas (80%), crescimento da pecuária (40%), desenvolvimento do ecossistema (77%) e saúde humana (67%). Além disso, os agricultores relataram redução nos custos de produção (49%) e rendimentos mais altos (46%) ao usar a Homeopatia e altas diluições dinamizadas como método agrícola. As entrevistas com pesquisadores, consultores e agricultores internacionais evidenciaram como diferentes formações profissionais podem se beneficiar ao aprender e usar a Homeopatia e DHDs na agricultura. As entrevistas corroboram as contribuições da Homeopatia e das altas diluições dinamizadas na agricultura bem como conglomeram informações importantes no desenvolvimento da Homeopatia como disciplina científica de significativo potencial transdisciplinar. Os resultados dos capítulos da tese estimulam diálogo na construção compartilhada do conhecimento ajudando a difundir e criar formas de conhecimento alinhadas aos interesses da sustentabilidade ambiental, agrícola e da equidade social. Esse estudo verificou que a Homeopatia e o uso de altas diluições dinamizadas constitui uma metodologia viável para promover a vitalidade dos agroecossistemas auxiliando no avanço bem-sucedido da prática e pesquisa agroecológica.

PALAVRAS-CHAVE: Agroecologia; Interdisciplinaridade; Homeopatia; Altas Diluições Dinamizadas; Vitalidade; *Fragaria* × *ananassa*

ABSTRACT

Agriculture is among the most important activities for humanity to thrive. However, the dominant practices employed in agriculture today are derived from Cartesian and mechanistic ontology. This approach to agriculture ended up threatening farmers' livelihoods and food security in general. Such practices had deleterious effects on ecosystems, significantly reducing biodiversity, contaminating soil, water and food with soluble fertilizers and pesticides. In contrast, agroecology offers a holistic model of agriculture based on the interactions of biodiversity and society, from methods that stimulate ecosystem homeostasis and the use of less toxic products to eliminate the food system's dependence on the use of pesticides and non-renewable soluble fertilizers. This study analyses the potential use of the agroecological method of Homeopathy and dynamized high dilutions (DHDs) in agriculture, investigating its bio-stimulating effect on plants and its contribution to the development of sustainable agricultural systems. This study explores through a multidisciplinary approach how understanding the vitality of the agroecosystem can contribute to the development of agricultural practices and research strategies towards sustainability. The thesis is presented in 6 chapters. Chapter 1: General introduction of the thesis; Chapter 2: The systematic review identifies and collates data on vitality in agricultural research over the past 20 years; Chapter 3: Presents the results of two-year agronomic experiments testing DHDs and their biostimulatory effect in strawberry plants (*Fragaria* × *ananassa*); Chapter 4: Presents and explores questionnaire data surveyed with farmers using Homeopathy and DHDs in agriculture, examining the impact that the method has had on their farming practices and how it promotes the agroecosystem vitality; Chapter 5: Discuss and presents the results of interviews with international stakeholders working with Homeopathy and dynamized high dilutions (DHDs) as a way to promote the vitality of the agroecosystem. Chapter 6: General conclusion of the thesis. The systematic review identified 21 scientific terms that address vitality in agricultural research, found an increase of 79.72% in the number of publications related to the topic since 2017. China, India, France, Germany, Poland and Brazil stood out as the countries with multiple publications on the subject. The results of agronomic experiments testing the bio-stimulating potential of DHDs in the *Fragaria* × *ananassa* crop, showed that mineral dynamized high dilutions (DHDs) stimulated production, growth and development of strawberry plants. The questionnaire revealed that farmers use homeopathy and DHDs because they have noticed improvements in crop

quality (80%), livestock growth (40%), ecosystem development (77%) and human health (67%). Additionally, farmers reported reduced production costs (49%) and higher yields (46%) when using Homeopathy and dynamized high dilutions as a farming method. The interviews with international researchers, consultants and farmers highlighted how different professional backgrounds can benefit from learning and using Homeopathy and DHDs in agriculture. Furthermore, the interviews corroborate the contributions of Homeopathy and the high dynamized dilutions (DHDs) in agriculture, as well as conglomerate important information on Homeopathy as a scientific discipline with transdisciplinary potential. The results of this study stimulate the creation of dialogue and shared construction of knowledge, helping to develop knowledge aligned with the interests of environmental and agricultural sustainability and social equity. This study verified how Homeopathy and the use of dynamized high dilutions (DHDs) can constitute a viable methodology to promote the vitality of agroecosystems, assisting in the successful advancement of agroecological practice and research.

KEYWORDS: Agroecology; Homeopathy; Dynamized High Dilutions; Vitality; *Fragaria* × *ananassa*; Interdisciplinarity

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SUMMARY

1. GENERAL INTRODUCTION

This section will introduce the thematic explored in this research. In addition, the philosophical and methodological approaches used in this research will also be presented. This chapter will set the bases for comprehension of the following chapters, which individually will specifically address one or more of the research questions.

1.1. Exploring innovations towards holistic agriculture

Agriculture is one of the most important activities for the humanity to thrive and recently, environmental, social and economic issues worldwide have been encouraging the review of paradigms in agriculture (WRIGHT, 2021). Such changes are reflected in the search for innovative farming methods as well as the focus on multidisciplinary dialogue to produce food whilst protecting the environment, calling up for change on the worldview and the way human societies interact with the ecosystem (GLISSMAN, 2014).

The word agriculture, according to Mazoyer and Roudart, (2010), is derived from the Latin *agricultūra*, from *ager* 'field' and *cultūra* "culture/cultivation". As the authors comment, more than its literal definition, the cultivation of the land reflects how humans changed their relationship with nature, switching it from one that was directed by nature to one where it is cultivated by man-nature relationship. However, the nature of this relationship is be framed according to different ontologies.

The current approach used in mainstream agriculture is the heritage of Cartesian and mechanistic ontology, which focus on understanding the parts rather the whole (BANCHETTI-ROBINO, 2011). Descartes (1637) proposed the reductionist approach - which consists of breaking down the observable reality into their minimum parts and arranging them in a logical order, to understand it – serving as the base for the forthcoming industrial scientific revolution which ultimately would assist the Industrial Revolution (WINNING, 2020). Within this understanding, any agroecosystem should be torn apart, and its components dealt independently. Interestingly, Lakatos (1978) summarized the Cartesian approach to nature as a fixed universe composed of elements (the atoms of atomism) that preserve their identity regardless of context and that any whole is taken to be a purely additive combination of its elements.

This worldview has influenced authors to argue that agriculture and food production should be dealt as any other industry, based on sectorization and interconnected input chains (CORALLO et al., 2018). Proposing that farming practices should focus on new technological approaches such as robotics and controlled environments to produce high volumes of food and fibre (BELFORTE et al., 2007). Some authors mention that the positive aspects of such an approach can be observed in all the modern technologies available today, which were only possible because of the mechanist/materialistic ontology (HACKING, 2005). In the same sense, it is argued that international policies should be focusing on industrial scales to solve food security and environmental crises (MULET, 2018).

The outcome of cartesian approach is a continued redress approach, focusing on chemical inputs to handle diseases and pests and to fertilize the soil, because they are identified as independent components (VANLOQUEREN 2009; WENCESLAU et al., 2014; NOGEIRE-MCRAE et al., 2018). Undoubtedly, the Cartesian approach has contributed to develop agriculture, nevertheless, unquestionably it has also created the problems we face today: an unsustainable system based on non-renewable resources, highly consumptive of energy and water, extremely dependent on external inputs and dangerously polluting (STREIMIKIS and BALEŽENTIS, 2020).

The evidence from agricultural research worldwide, points out that the remediation approach in agriculture is responsible for increasing the appearance of new pests and diseases, killing off pollinators, soil degradation, water contamination and endangering family farmers livelihood (MACHADO et al, 2014; MAHMOOD et al., 2016; PIMBERT et al., 2017).

In denying this intrinsic understanding, industrial agriculture has caused huge impacts on the environment and for decades now, research has proved deleterious effects of such practices on the ecosystem, for example, compromising carbon sequestration, altering hydrological rhythms, biodiversity lost and increasing persistent hunger worldwide - even though huge quantities of food are produced (PIMBERT et al., 2017). Such impacts were estimated at a value of US $33 trillion a year (ALTIERI, 2002).

Nevertheless, valuing these impacts only through the monetary optic is not enough. Overexploitation of natural resources have also inflicted a major danger to human health because the decline in fundamental ecosystems, caused by a non-stoppable industrialization (DUBÉ et al., 2012). Many people have been under the illusion that these ecosystem services are free, invulnerable, and infinitely available (KIBBLEWHITE and

SWIFT, 2008). Altieri (2002) argues that partially, this misunderstanding reflects a knowledge gap, where people thinks that food can be produced on artificially modes and relying exclusively on external modern technological tools.

To overcome the above cited problems, advances in disciplines such as agroecology, offer a holistic approach that embodies processes, the environment, and culture all as constitutive features for any agricultural production (PRIMAVESI, 2018).

To put in perspective, to approach anything holistically means to understand that the whole is not an aggregate of independent elements but an organized system, each part being defined by its relations to other parts and to the whole, meaning that the analysis of parts must occur in the context of the parts' functioning in the whole (FREEMAN, 2005). Holism as an axiom is the principle that propose the identities of objects and events derive from the context in which they are embedded, where the whole defines parts and parts define the whole, composing a coherent set of intertwined ontological and epistemological principles (DREYFUS, 1980). Holism as a scientific method approach makes possible to investigate complex systems such as ecosystems, climate systems, social systems whose behaviours cannot be understood by studying the individual system components in isolation (HEALY, 1991). For agriculture, the holistic approach is the solution to overcome agriculture problems, and agroecology can synthesize this holistic axiom and its applications at its best (BOFF, et al., 2021).

Some examples of holistic approach within the agroecological farming methods are the permaculture principles (HOLMGREN and MOLLISON, 2020) where the farm is designed to accumulate water and biomass (plant and manure) that will be used as fertilizers for crops or food for husbandry in a cyclical process. Also, the biodynamic farming methods proposed by Rudolf Steiner and Ita Wegg (TURINEK et al., 2009) which considers the landscape as a single organism, focusing on development and interrelationships of the soil, plants, animals and their spiritual counterparts for a self-sustaining system (ZANARDO et al., 2020). Biodynamic agriculture uses various herbal and mineral components for compost additives and field sprays, some of which are high-dynamized dilutions (KOLISKO and KOLISKO, 1978; ZANARDO et al., 2020), a similar approach is used by the Agrohomeopathy.

Agrohomeopathy is a form of agriculture that uses homeopathic principles and preparations to enhance crop growth and health (KAVIRAJ, 2012). It is based on the idea that plants, like humans, can benefit from treatments that stimulate their natural ability to heal and maintain balance (BOFF et al., 2021). Agrohomeopathy practitioners argues that

this approach can help to improve soil health, increase crop yields, and reduce the need for chemical inputs (SEN et al., 2018). Some of the techniques used in agrohomeopathy include the application of homeopathic preparations to the soil or to the plants themselves, the use of biodynamic preparations, and the use of holistic crop management strategies (MORENO, 2017; BOFF et al., 2021). Agrohomeopathy is still a relatively new and controversial field, and more research is needed to fully understand its potential benefits and limitations.

Therefore, Agroecology offers a holistic model of agriculture based on diversifying farms and landscapes, using non-toxic products, optimizing biodiversity, stimulating interactions between different species, as part of strategies to build soil fertility, guarantee yields and secure livelihoods (MCMICHAEL, 2016). After decades of studies and increment on the number of farms producing agroecologically, data has shown that agroecological systems can contend with industrial agriculture in terms of total yields, performing particularly strong under environmental stress (JOHNS et al., 2013; PRIMAVESI., 2018).

In particular, Agroecology embeds natural and social sciences, aiming to connect complementary facets, putting biology and sociology to be understood fully only through each other (GLIESSMAN, 2014). By virtue of such entanglement, ecological functions establish interdependence with human interaction, and through that action, spontaneously put the agroecosystems to self-organization (LOVELOCK, 2003). Agroecology considers the human being as part of the agroecosystem and not as an outsider or controller of nature, which is crucial to develop sustainable activities (GLISSMAN 2014; MORRIS et al., 2022).

Still, there are some issues to be addressed. Wagenet (1998) mentions that scaling up agroecological products are challenging, being one of the reasons for the lack of availability of these products on market shelves. Other reasons addressed are the need for improving marketing, networking, and information exchange with farmers and consumers (NIEMEYER and LOMBARD, 2003). In this sense, Reddy (2010) argues that supportive public policies are highly needed to improve research and entrepreneurism regarding agroecological farming.

Although the challenges are a fact, agroecology and its holistic approach are still one of the most valuable tools to solve the structural problems created by industrial food systems. More than that, it represents a freedom attitude to break a series of vicious cycles, helping to decrease the external dependence on chemical fertilizers, pesticides,

and the use of antibiotics (GLISMAN, 2014; NEFF ET AL., 2015; PRIMAVESI, 2018), offering diverse ways to reduce the environmental and economical inequalities (MCMICHAEL, 2016; PIMBERT, 2017).

It is relevant to mention though, that agroecology also must improve its notions of holism in farming systems. Wright (2021) argues that agroecology could only be considered as totally holistic if it considers subtle phenomena and subtle methods used to interact with nature.

More recently, the use of holistic methods such as agrohomeopathy and biodynamic farming were included under the innovative line of research named Subtle Agroecologies (Table 1). Explained in a resumed way, Subtle Agroecologies doesn't constitute a farming system in itself, but superimposes a non-material dimension upon existing, materially based agroecological farming systems (WRIGHT, 2021). Subtle agroecological practices are grounded in the lived experiences of humans working on, and with, the land and with nature, over thousands of years to the present.

Table 1 – Subtle Agroecological Practices

Agro-homeopathy	Astronomy/ planting calendars	Biodynamic preparations
Communication with other-than-human	Dowsing	Electromagnetism
Feng Shui/ Geomancy	Intuition/direct knowing	Mantras/chanting
Paramagnetism	Prayer/intention	Psychoactives /teacher plants
Radionics	Ritual	Sacred geometry / 'organising forces'
Sound/ultrasound	Water dynamisation	Brews and potions

Source: adapted from Wright 2021.

This research was interested in the perspective from two major strands of subtle techniques that have been largely used in farming systems across the globe: agrohomeopathy and biodynamic farming (BOFF et al., 2021; PAULL and HENNIG, 2020). These two approaches are articulated over a set of knowledge and practices that have interconnected dimensions: a concept of a vitality; a therapeutic system (which explains the nature of health and disease); a diagnostic system; and a cosmology that

presents the worldview that provides the basis for the previous dimensions (WENCESLAU et al., 2014; PARAMESH et al., 2015; PAULL, 2011; HAHNEMANN, 1842). Even though having similarities they do not follow the same principles nor the same methods to make the organism diagnosis (FISHER, 2012).

Beside the ontological similarities mentioned above, both methods also share other important methodological characteristics: their preparations come from natural sources and are made under unique circumstances and methods; they have a holistic way to understand and manage the system; both approaches view farms as a living organism; the preparations act over the organism's vitality (LOVEL, 2014; OLIVEIRA et al., 2019).

It is interesting to notice how homeopathy and anthroposophical medicine, both human therapies – have developed an agriculture branch. Within the holistic worldview of these two methods, the interconnectedness of the components within an agricultural system leads to presuppose that what makes the soil, water, plants or animals sick does the same for humans (KHATOUNIAN, 2001; BOFF, 2009; CASALI et al., 2009; PARAMESH et al., 2015; BAVEC and BAVEC, 2015).

Recently, their benefits for human therapy and agricultural practices have led to the methods to be integrated into public services in some countries. For instance, in Brazil since 2006 the Integrative Practices Program has included in the national health service (SUS), practices such as homeopathy, anthroposophical medicine, ayurvedic medicine, reiki, acupuncture and more. In the same sense but regarding agriculture practices, since 2004, homeopathy and biodynamic farming were legally included as organic approaches for food production (BRAZIL, 2011).

Despite the numerous methodological and ontological similarities, perhaps, the strongest bond that both approaches share is the use of dynamized high dilutions (DHD).

1.2. Dynamized high dilution (DHD)

The term dynamized high dilutions (DHD) referrers to the technique of sequential dilution and dynamization process of a substance (BONOAMIN, 2020), and according to the La Groupe International de Recherche sur l'Infinitésimal (G.I.R.I) the technique shouldn't be exclusively linked to homeopathic or biodynamic preparations.

The term dynamized high dilution (DHD) defines any solution that has been produced using the technique of sequential dilutions and succussions – producing

therefore a dynamized solutions (RUPP et al 2012; SEN et al., 2018;). A homeopathic preparation, however, is a dynamized solution in such level called potency that is described into Homeopathic Pharmacopeia. Another difference is observed in the fact that the term DHD is commonly used by researchers from across disciplines who investigates the potentialities of DHD on the fields such as physics, chemistry, crystallography, material sciences and others. On the other hand, the term homeopathic preparation is commonly used pharmacy, medicine etc. In studies in agriculture both terms are utilized and the purpose of research they are equivalent

According to Lovel (2014), one explanation for the use of dynamized high dilution in agriculture could be elucidated in this way: farmers who think only of particles share the world view that everything around us is made up of particles with mass - these farmers will eventually support their crops solely with particles, for example adding chemical fertilizers or applying pesticides etc. On the other hand, farmers who think of waves/vibration share the world views that the nature expresses itself as vibrational patterns – thus these farmers will eventually support their crops with biodynamic and homeopathic preparations, sounds, mantras magnetic impulses or transmit UV frequencies and others (LOVEL, 2014).

This kind of mindset is supported by the innumerous implications of the quantum and resonance theories (HARAMEIN, 2013). Plank (1858 -1947) and Bohr (1885 - 1962) explained on their Quantum Theory, that just describing the reality from a particle perspective is incomplete and incorrect, all particles also have a wave nature and vice versa (NAUENBERG, 2016).

There is no unanimous explanation for the observable effects of the dynamized high dilutions over biological systems. However, some plausible arguments can be considered when linking the effects of DHDs with the wave-nature theories such as the quantum physics (PLANK, 1922) information theory (BERTALANFY and SUTHERLAND, 1974), and morphic resonance (SHELDRAKE, 2009). In doing so, one can comprehend DHD would act like an electromagnetic pulse (figure 1) in the system; this pulse transmits a set of information to the system and the information is carried by the means of the DHD.

Figure 1 - Electromagnetic irradiation pulse pattern of a dynamized high dilution (DHD) obtained with a Transmission Electron Microscopy.

Source: Chickamane et al., 2010

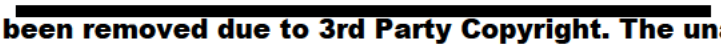
Now, information is a term with many meanings but when taking the perspectives from information theory (BRILLOUIN, 2013), information is related to stimulus, like in any pattern represented (wavelength, frequency, pixel etc), having the quality to send the message (BEKENSTEIN, 2003) from the sender (in this case the DHD) to the recipients (biological system). This view assumes neither accuracy nor parts that directly communicate, but instead assumes a separation between the object to and its representation, as well as the involvement of someone capable of understanding this relationship (SERRA, 2007). In this case, we have to consider nature and the ecosystem as a system capable of receiving diverse forms of stimulus or information patterns (BRIGHTMAN al., 2015, AL-KHALILI and MCFADDEN, 2016).

This understanding has a very pragmatic application. Energy can be transferred by vibration or electromagnetism and turned into information that ultimately leads to a response in the form of a stimulus (ENGEL, 2007). One of the most fundamental aspects of quantum physics is the idea that energy, and therefore the information it contains, is quantized and this connects to a specific amount of the energy's frequency, down into the smallest possible parts (HAREMEIN, 2013).

Max Plank in 1918 proposed the radical idea that materials called quanta vibrate at certain discrete frequencies. His simple and radical theory drew him completely away from the classical theory of radiation. For Plank, energy was considered to emanate – like

a pulse – and frequency and energy were closely related (HARAMEIN, 2013). Soon after, in the late 19th century, the Scottish physicist James Clerk Maxwell demonstrated that electrical and magnetic forces were two facets of the same electromagnetic force (figure 1.3).

Figure 2- Electromagnetic wave/particle pattern



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Source: Available in https://minerva.union.edu/malekis/CVision2003/MainPage/Course%20Content/Osc&waves/E&MWaves.htm, 2021

According to Norton (2013), these smallest parts or quantum entities exhibit a quantum coherent behavior, like being in two places at once, spinning in two directions at once, tunneling through insurmountable barriers, or having eerie tangled bonds with a distant partner – the quantum entanglement. The quantum entanglement (figure 3) would then explain how electromagnetic structure of the starting material is transmitted through out the DHDs.

The quantum entanglement allows particles that were once together to remain, in instantaneous communication, despite being separated by immense distances or dilutions (ARBAB and AL-AJMI, 2014). Quantum entanglement explains how smallest particles - as atoms - transmit information patters *ad eternum* influencing biochemical reactions (SHULTEN, 1976). In 1982, Alain Aspect in Paris demonstrated through experiments with polarized light photons the phenomenon of entanglement.

Figure 3- Quantum field information.

Source: Life in the Edge, Al-Khalili and McFaden, 2016.

As mentioned above, a complementary assumption is related to information exchanges from the Systems Theory (BERTALANFFY, 1967), which stresses the importance of exchanges of energy, matter and information among living organisms and their external environment, at all levels, from the quantum to the macro-dimensional. The system theory would then lay the bases used by Manzalini and Galeazzi (2019) to explain dynamized high dilutions under a quantum electrodynamics, proposing that the homeopathic preparations (DHD), have each a microwave function with its own oscillatory pattern, that resonates with other specific oscillatory patterns (organism) in a perfect orchestration of multiscale coherence and resonance. Thus, obtaining a biological response.

In fact, the principle of resonance is a fundamental aspect of the wave-particle understanding of nature. The principle of resonance as explained by Haramein (2013), is triggered when a system's natural frequency, or relative vibration rate, matches the relative rate of vibration or range of frequencies. In other words, the energetic resonance occurs when an electromagnetic pulse acting on a system coincides with its natural frequency of vibration. A useful example to clarify the resonance principle is given below:

"Examples of this natural frequency of vibration are the sympathetic vibration of a stretched string in response to an appropriated sound wave; the tunning of the radio set to the frequency of a particular radio wave frequency given out by transmitters; the absorption of light waves or particular wavelength by atoms and molecules and atomic nuclei in the presence of magnetic fields to electromagnetic radiation in electronic spin resonance and nuclear magnetic resonance. Common to all this these types of resonance is the principle of selectivity: out of a mixture of vibrations, however complicated, the systems respond only to a particular frequency" (SHELDRAKE, 2009, pg 85).

To summarize Sheldrake's theory (2009), it assumes that all living systems are influenced by morphogenetic fields during their development process. The resonance morphic fields are energy-like but are neither a type of mass nor energy *per se* and would operate more likely as a kind of information pattern, however, this energy is related to the wave-particle nature and analogous to energetic resonance in its specificity, but not explicable in terms of any type of resonance, nor does it involve the transmission of energy (SHELDRAKE, 2009). This exchange may take place through time and space. According to him, the exchange of bio-information is primarily mediated by electromagnetic fields. Any disorder in Sheldrake's view arises when an electromagnetic field is disturbed and fails to maintain its equilibrium. However, it's important to mention that morphic resonance fields are still not widely accepted in the scientific community, as most of its methodology are still under theoretical essay and more empirical data is needed to further develop this theory.

Non the less, interconnecting these assumptions by means of a multidisciplinary background - quantum theory, resonance patterns, systems theory, information theory, morphic resonance theory, etc. – it could be hypothesized that in the process of dynamization, the DHD information maintains itself throughout the entire dynamization process, under the influence of the starting material, explaining specific energy/resonance patterns as observed in studies that looked into the DHD by its electromagnetic nature (CHICKAMENE et al., 2010).

However, in considering these theories, it would eventually lead to the question: How is the information/resonance pattern created in the DHDs in the first place?

1.3. Water as vehicle and information carrier

It seems as though that water has a crucial role in this process. Russo et all (2017) explains that water is the known substance with the biggest number of physic-chemical

and biological anomalies (63), due to its electrochemical characteristic with tetrahedric hydrogen bonding and dipole distribution. A wide range of atypical properties are attributable to this structure, including the including the Earth's climate.

Water is one of the most important elements for life to thrive. It's one of the most common but also one of the least understood substances. For example, it's the only substance that naturally exists in three states (liquid, solid and gas), it has the highest surface tension of all liquids, it creates the structure of proteins and, it's the most powerful solvent on earth (Taiz et al.,2017).

Interestingly, studies have shown that any substance that gets in contact with water leaves a trace, because of water unique electrochemical nature, it tends to form clusters of the substances that are dissolved on it, thus adopting its properties, recording this information on its electrochemical structure (HANKEY 2019; MEESSEN 2021).

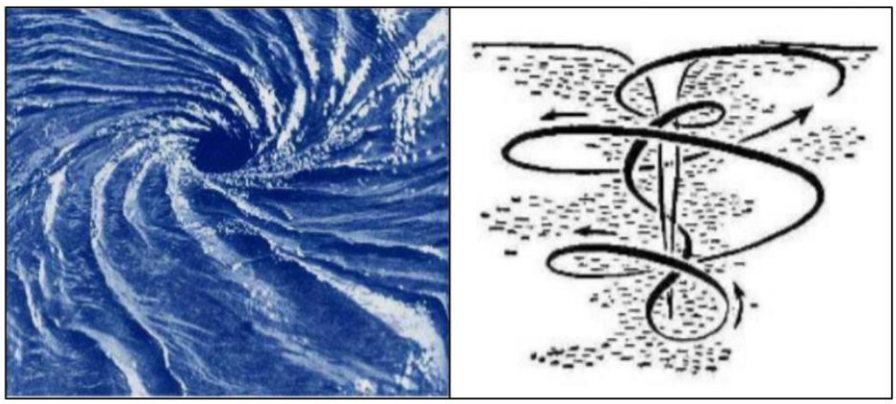
The phenomena of crystallization and transferring of electrochemical structure in water molecules happen via the process of coherence and epitaxy. Bellavite et al. (2014), explain that due to the heterogeneous composition of water, its electrochemical structure can be influenced by interactive phenomena such as coherence and epitaxy – on which the atomic structure of any template structure is transferred to a liquid without any material transfer. This process is often used in the semiconductor industry to produce thin layers of semiconducting solutions for use in electronic devices (BELLAVITE et al. 2014). Furthermore, water coherence also transfers electrochemical structure as observed in the process of colloidal nanobubbles formation. These nanobubbles contain gaseous inclusions of oxygen, nitrogen, carbon dioxide, silica, and the original active ingredient. In this way, water molecules serve as nucleation centers, amplifying the formation of supramolecular structures and organizing the solvent (BELLAVITE et al., 2014).

Similarly, other authors point out to water as the vehicle for containing and transferring information. Chikramane and colleagues (2010), suggest that succussion process on dynamized high dilutions causes acoustic cavitation, which transfers the DHD information throughout its process. They were able demonstrate the correspondent electromagnetic pattern between the nanoparticles of the DHD and the ones of the starting material. Previously, Reys (2003) had also confirmed that, despite their dilution beyond the Avogadro number, the HDD's emitted light was specific of the original salts dissolved initially and they had correspondent irradiation patterns. Bonamin (2008) also suggests that this effect, which is similar to that of electro-magnetic fields, is the result of an ultra-molecular action, and that information is exchanged with the living organism through

dynamic structures of communication, which are continuously modified when information with the inner and outer environments is changed.

It's possible to assume then, that the dynamization process (figure 4), whether by the vortex (CHEN, 2019) or succussion (SCHWUCHOW et al., 2013), influences the quality of a solution; and that the pattern is transferred through vibrations created by the dynamic movements having electromagnetic identities (POLK and POSTOW, 1995; GEESINK et al., 2016).

Figure 4 - Sources of cavitation in water



Source: Adapted from Chen, 2019.

The importance of studying dynamized high dilutions (DHD) could be borrowed from Nicolai Tesla (1956 – 1943) who said "*The day that science begins to study non-physical phenomena, it will make more progress in a decade than in all previous centuries of its existence*"

It's clear that the DHD offer an innovative, non-conventional methodological and epistemological approach to agriculture that should be investigated to be better understood.

1.4. Homeopathy in agriculture

Throughout the world for more than 200 years, homeopathy has been used as a science and art of healing (BOFF et al., 2021). It was created by the German physician Samuel Hahnemann in 1796 as a therapy for humans and since then, homeopathy has

been expanding in areas beyond human medicine because of its capacity to act on all living systems (NUNES et al., 2021).

Its method analyses the organism issues as a whole rather than focusing only a specific part of the system (eg., pest or disease problem in agriculture). This line of though aligns with the one of the systems theories (BERTALANFFY, 1967). According to Silva et al (2022), in light of the biological response observed with the use of homeopathic preparations, it seems reasonable to assume that the curative property of homeopathy may be preserved in the hydroalcoholic solution of the high dynamized dilutions.

Nonetheless, some authors argue that homeopathy lack of scientific evidence. Mullet (2018) discusses that homeopathic remedies usually continue well past the Avogadro number; therefore, no molecule of the original preparation remains in the solution, constituting a biochemical problem. According to Cartesian science, this ought to limit the action of the homeopathic preparation (SILVA et al., 2005), and this fuels the argument that a placebo effect is involved.

However scientific evidence shows otherwise. The homeopathic preparations can be explained by extrapolating mechanistic rationality through nonlinear systems models (BELL et al., 2002; BONAMIN et al., 2008). Homeopathy has had its theoretical-methodological framework legitimised by scientific peers in several internationally recognised journals working in agrarian and/or related sciences (BETTI et al., 2009; BONFIN and CASALI, 2012; JÄGER et al., 2015; ÜCKER et al., 2018; PEREIRA et al., 2019). The biological effects of the original ingredients have been proved methodically and consistently in plants, animals, and people despite their apparent absence of molecules (BONFIN et al., 2012). Also, double-blind trials have eliminated the possibility of a subjective (placebo) effect between the patient and the researcher (BETTI et al., 2009).

1.5. The impact of applying homeopathy in agriculture as a means to promote plant growth and control pests and diseases

As discussed previously, the current agriculture models heavily rely on the use of agrochemicals including pesticides to manage crops. Consequently, food and ecosystems have been contaminated leading to ecosystem destruction and compromising food health security and sovereignty (PIMBERT et al., 2017).

Therefore, the non-pollutant, non-toxic, non-residual and biodegradable nature of homeopathic preparations offers an alternative to be used in agriculture without compromising the ecosystem and contaminating food (MORENO, 2017).

To illustrate the potential of homeopathic preparations in agriculture, it's important to investigate the scientific information by peer-reported data. This data informed that homeopathic preparations (DHDs) have being used successfully in agricultural research.

For instance, to manage plant disease, the homeopathic preparations of *C. citriodora, C. carbonica, Silicea* and *Sulfur* showed potential as elicitors of peroxidase, catalase, kinase, β-1-3-glucanase and phytoalexins inducing the biochemical defense mechanism of bean plants (OLIVEIRA et al., 2014). In vitro studies, the homeopathic preparation *Natrum muriaticum* 5CH inhibited *Aspergillus niger* growth in 66% (GAMA et al., 2014). In field trials with beans, *Sulfur at 12 and 30CH, Ferrum sulphuricum* at 6, 12 and 30CH and Propolis in all dynamizations reduced disease progress curve by 17% to 49% (TOLEDO et al., 2015).

Also, widely reported are the use of homeopathic preparations as plant vigour promoters. Panda and collegues (2013) increased seed germination, seedling development and photosynthetic activity in pea plants using *Propolis* at 30 and 60CH, increasing root volume by 39 and 33%, fresh shoot mass by 35% and dry root mass by 38%. With onions, *Sulfur* 12CH increased shoot mass by 23% to 37%, and at 60CH increased root mass by 59%, as did *Ferrum sulphuricum* 60CH (65% increment) (TOLEDO et al., 2015).

Another very important feature of homeopathic preparations resides in the fact that it does not act against the organism or system itself but rather promotes an equilibrium of it. An example to illustrate this, are the results from Giesel et al., (2016) using *Belladonna* 6CH and 30CH, which significantly reduced the foraging activity of ants, *Acromyrmex laticeps Emery*, which were causing a problem for pastures in Santa Catarina/BR. Therefore, the colony of ants itself didn't have to be eliminated.

The positive impacts of using homeopathy in agriculture, have proven it itself as an ecological tool, in harmony with the concept of sustainability (BONAMIN, 2020). Therefore, in 2004 the use of homeopathy in agriculture was certified by UNESCO as an effective social technology, meaning that this technology has the potentiality to solve social problems of rational and ecological land use to produce healthy food, respecting biodiversity and eliminating the use of pesticides (KHOLER and NEGRÃO, 2018).

1.6. Challenges of applying homeopathy in agriculture

Homeopathy is primarily based on the principle of similarity (CARNEIRO, 2011). Essentially, this means correlating the symptoms described in the Homeopathic *Materia Medica* - originally developed for and on humans - to those of diseased plants and animals. The preparations should be selected based on the "total" set of symptoms/indicators (VIGANÒ et al., 2015). However, these approaches were not categorized and there is a need to have them as a source of reference for literature and practical and research purposes. According to Teixeira e Carneiro (2017), the existence of systematic preparation selection is needed, and it would facilitate the selection of the individualized drug for each plant species and type of disease.

One more challenge regards the preparation potency to be used. This is mostly decided upon based on the practitioner's experience as the main decision parameter, while other practitioners use electronic instruments, electro-acupuncture devices or pendulums and in some cases intuition (GREENHALGH, 2002; JONAS et al., 2003).

These two features are crucial because a proper selection of the remedy and its potency is the most effective way of ensuring the long-term health of the agroecosystem (BOFF, 2009). With that in mind, research on agrohomeopathy should consider collecting more data on DHD's selection, modes and frequency of application etc. (CORREOSO et al., 2022). Another knowledge gap identified as crucial to enhance the debate and use of homeopathy in agriculture is the nuances of crop vitality promotion. According to many authors, the major benefit of using homeopathy is the promotion of vitality, health, or harmony enabled by a dynamic force (PARAMESH et al., 2015), which ultimately is endorsed by homeopathic preparations.

1.7. The underlying question of vitality in agriculture

Understanding the concept of vitality manifestation in agriculture is essential for this research. Firstly, because one of homeopathy's axiom is its action over the vitality of the organism. Secondly, the ontological implications of exploring vitality could help to reframe the agricultural research and practices towards sustainability. Therefore, comprehending and assessing vitality is included in this research. However, this task needs a thoroughly analyses.

The word vitality according to the Oxford dictionary (2010) comes from Latin *vīta* 'life'; from middle French *vitalité*; is the capacity to live, grow, or develop; to have energy or vigour; liveliness, spirit, spiritedness, high-spiritedness, vivacity. Now, this definition helps us to understand why the word is so commonly used in daily life when trying to express something on its best condition/state. For instance, architects and urbanists use the term revitalizing for renewing a park or a building to better conditions of use. In the same way, psychologists, nutritionists, and other therapists refer to the term when directing measurements to improve one's life quality. Perhaps from the medical care, the expression vital functions express its best pragmatic meaning… functions that allows one to be alive.

However, in agriculture the term is scarcely used. This constitutes a paradigm difference because an agroecosystem itself is a complex living organism (LOVELOCK, 2003).

So why is the term not commonly used in agriculture? When examining the literature on vitality, it was possible to draw some inferences.

For a start, this could be linked to the ontological tension between the Vitalist philosophy and Materialistic philosophy that continues to the day (BANCHETI-ROBINO, 2011). The term vitality is rooted in western societies to Vitalism, an ontological perspective that shaped the intellectual and scientific thought from the 16th century until late 18th centuries (ALLEN, 2005). Briefly, vitalism is the doctrine that affirms the existence of an irreducible principle to the physical-chemical domain to explain the vital phenomena. In this conception, the physical body of living beings is animated and dominated by an immaterial principle called *vital force*, whose presence would distinguish the living being from inanimate bodies and its lack or failure would determine the phenomenon of death (NORMANDIN and WOLFE, 2013).

Moreover, the difference between organic substances (only produced in nature) and inorganic substances (synthetized by man) would be distinguished by the action of the vital principle (FONTECAVE, 2010). However, it was during the 1800s when biochemistry was developing its methods to explain life manifestation that the discovery made by two German chemists Friedrich Wöhler (1800–1882) and Justus Von Liebig (1803–1873) put vitalism aside from mainstream science. For the first time a biological compound (urea – a nitrogen substance) was produced under an artificial environment. This result demonstrated for the first time that a biological molecule could be made without the assistance of vital functions. From that period onwards and with the aid of the

reductionist approach to biology and chemistry, the scientific community alleged that life could be solely explained in terms of chemical and physical reactions (HÄGGLUND, 2016).

However, while the reductionist and non-vitalistic biochemistry evolved, one of the most prominent scientists of that time, Louis Pasteur (1822–1895), through his discoveries of molecular dissymmetry and fermentation, revived the vitalist view at the end of the 19th century. According to him, these fascinating properties were indissociably tied to a living organism and could only be explained in terms of an unknown force that specifically ensures they are introduced to living systems (FONTECAVE, 2010). Fascinating is the fact that one of the most significant contributions of vitalism to the history of science was its influence on the development of the theory of evolution. Many early proponents of evolution, such as Jean-Baptiste Lamarck and Erasmus Darwin, were influenced by vitalist ideas and believed that the vital force was responsible for the evolution and adaptation of living things (BANCHETI-ROBINO, 2011).

The situation is thus highly paradoxical.

The ontological tension between the vitalist philosophy and materialistic philosophy can also be observed over the historical identification that scientists tend to link themselves in a sort of knowledge heritage or tradition. In that period (16th and 17th centuries), the vitalism dominated the natural philosophy and it hold within its epistemology the Neoplatonic and hermetic traditions which were strongly correlated to alchemy, even during the transition from alchemy to modern chemistry (NORMANDIN and WOLFE, 2013). Bancheti-Robino (2011) explains that there is no figure like a Euclid, Archimedes, or Ptolemy in the history of chemistry, instead, modern chemists find themselves in the somewhat disconcerting company of alchemists, druggists, sorcerers, astrologers such as Paracelsus (1493–1531). Although Paracelsus's chemical philosophy contained many mystical elements, it also contained elements that would later become modern chemistry and modern scientific method (BANCHETI-ROBINO, 2011). Therefore, for validation purposes and to be accepted as a “modern science”, its historical roots linked to metaphysical disciplines that dealt with vital forces should be avoided. This scenario still hasn’t changed, so a term that could possibly being linked to such nuances should be avoided when trying to explain how well an organism manifests.

This idea of a vital force as a life force that somehow transcends the known material world overall is marginalized in current western thought, even though this concept is intrinsic to, and widespread across, different cultures and times throughout

human history, both in western and eastern ontologies (POOLE et al, 2006). Some concepts related to the vital force are displayed in the table 2. Normandin and Wolfe (2013), explains that humanity when observing and studying nature, constantly experienced a supra physical element to its manifestation. The authors explain that by acknowledging this facet, humanity was able to integrate practices that not only delt with the physical issues of human and crop health. This approach has influenced the development of medical and agricultural practices, bonding the treat of the land and human organism in a complex organism that should have tools or approach to deal and interact with the different levels of life manifestation. In agriculture for example its common to see a mixture of common practices like sowing and harvest aligned with rituals aiming to both at the same time, perform physical and metaphysical outcomes (NORMANDIN et al., 2015).

Furthermore, Oyama and collegues (2010) point out, that with the evolution of biological theory, new concepts such as organicism, complexity and systems theory, homeostasis and others resuscitated vitalism, even though under new terms. These terms express vitalistic thoughts without using the "bed word vitalism or vital force" and are accepted in current scientific dialogues (GILBERT et al., 2000; HUNEMAN et al, 2010). Driesch (1867 -1941) adopted the term entelechy, taken from Aristotle, to describe his belief in a teleological nature in living things that challenged the mechanistic synthesis in biology prompting biologists to ask questions about the driving forces in cell development, a call that was severely criticized. All in all, contemporary biological debate acknowledges that there may be such a thing as a "vitalism heuristic" in biology and ecology (CHANG, 2011), however, it is still seen as an outsider in modern biology.

Table 2 - Vitalist conceptions across different periods and cultures

Origins	Ontological Principle	Axioms	Description
	Pneuma	A universal principle that permeates all nature, living and inanimate beings, acting towards cohesion, harmony and balance It hem to harmony and balance.	*Vis medicatrix naturae* Nature has the capacity to heal and harmonize itself An immaterial energy that makes life possible

Greek and Egyptian thought	Phys	An *archeus* or a ruling principle of the universe	A universal energy that coexists with the body allowing life manifestation
	Humors theory	Energy animates the body, and its functionality depends on the balance of the 4 *humors*: blood (fire), black bile (air), yellow bile (earth, phlegm (water)	Stabilized the bases for the allopathic intervention – e.g., fever (fire) should be treated with cold (water) Any unbalance in the being was caused by excesses or lack of the four constituent elements of nature.
	Aechaeans	Universal principle that animates and shapes nature and manifest itself in nature through "signatures" or forms	Use of mineral, plants and animals "signatures" to treat people, animal and crops. To create preparations to achieve a archeus who preside the functions of the organs – biological responses
Renaissance and post modern	Vital force	A dynamic universal principle that primarily keeps the harmony of any living system. It is an autocratic immaterial force that drives organisms toward its maximum expression of life	Vitalism – a force that insufflates life and organization in nature Use of homeopathic preparations to sensibilize the vital force and re-establish harmony
	Entelech	A dynamic universal force that drives all biological system towards is maximum potential of life manifestation	A fundamental metaphysical force that enables biological systems to perform their physicochemical metabolisms and roles in a harmonious way.
	Chi	Universal force that permeates and shapes everything. Commonly observed in traditional Chinese Japanese and Korean medicines	Universal energy compost by 5 elements/essences. *Ad eternum* balance movement principle know as yin - yang
	Prana	Etheric and material forces are entangled	Use of ayurvedic preparations and

Indigenous and eastern traditional knowledge		and influence each other directly. Based on indigenous yogi.	rituals to treat human, animal and land
	World Spirit	Based on indigenous traditions across the globe. It involves attributing sentience to the environment, people, animal, plants specific rocks and places	Based on animism and panpsychism Diverse forms of ritual and preparations performed in specific time of the year using specific materials to interact with spirits that are part of the nature.

Sources: Adapted from Pole et al., 2006; Normandin and Wolfe, 2013; Normandin et al 2015.

Despite the criticism from the western scientific sphere, the concept of vitality shows its versatility by being applied within the context of philosophical, natural-historical, psychological and biomedical reflections on the nature of living beings to designate even biopolitical positions (GAYON et al, 2010; NORMANDIN, 2011).

It's also clear that much of the discussion of vitalism has been either overly enthusiastic, or overly negative. However, it is impressive that vitalism continues to re-emerge in the life sciences in all sorts of fascinating, complex, dynamic, even heretical ways in our theories of knowledge (FEYERABEND, 1975; GRECO, 2005; WAISSE-PRIVEN, 2009).

In the history of vitalism, there are many facets that can't be separated from the metaphysical and the material, reductionism and holism, the inert and the animated, the structuring and the liberating, order and chaos, the dead and the living, rigidity and fluidity, structure and spontaneity, and even old and new. Vitalism evolves and changes over time, which gives it a vibrant life of its own (WAISSE-PRIVEN, 2009).

Therefore, assessing vitality in agriculture would be useful to explore and expand the relationship regarding plant growth and production, pest and disease resilience and food quality. Also, it would be fundamental to understand how people experience the phenomena (vitality) in order to foment the debate on research and agricultural practices. Because the term helps to raise questions about practices that affect human goals such as yields, food quality and human wellbeing. In addition, exploring vitality in agriculture would be useful to describe tacit knowledge end heuristic perspectives, which can help to

generate innovative forms of knowledge, because it does not limit to understand its functionality by its parts, but rather how well the parts are coexisting. In this sense, evidence obtained under a multidisciplinary approach could possibly led to a better comprehension of the phenomena of vitality.

1.8. Research objectives and general methodology

In this research, the objective was to evaluate the potential use of homeopathy and dynamized high dilutions (DHDs) to substitute the use of pesticides in agriculture and to assess how a deeper understanding of the vitality in the agroecosystem could help to improve farming and research strategies.

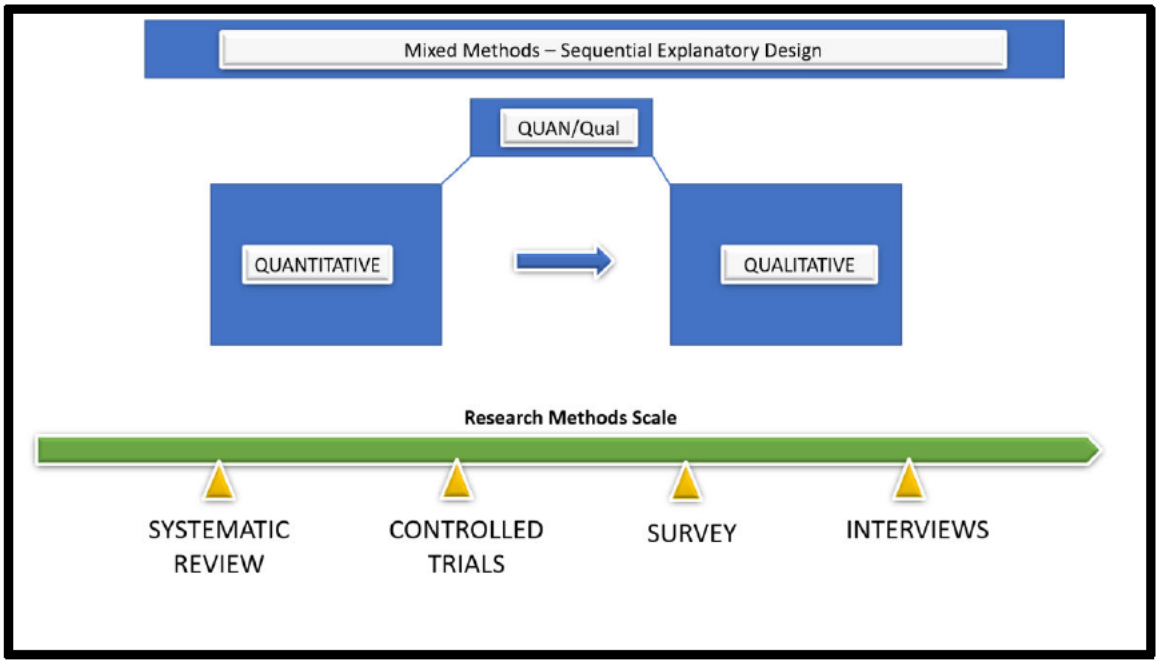
To answer the research questions, this research design uses a hybrid epistemology and methodology, combining natural and social sciences in the study framework. From the natural sciences, the study takes advantage of the positivist and etic approach to nature, based on quantitative data and its properties, observed through logic and reasoning, ultimately leading to a deductive analysis of the results (MACIONIS and GERBER, 2011). From the social sciences, the research is empowered with the relativist approach to reality, constructed via qualitative data, examining the meanings as well as the particularities originated from the human component, leading to a subjective analysis of the phenomena (PATTON, 2014).

At first, the contrasting approach could be seeing as antagonistic, however, as Knox (2004) points out, methodologies are best used in a complementary way to ensure the bigger picture is not lost. It is important to mention though, that they are used at different stages and for different areas of the research. The research design aimed to collect qualitative and quantitative data, using a mixed method sequential exploratory design (CRESWELL, 2015).

Figure 5 displays a diagram containing the mixed methods sequential explanatory design and its research elements. The data variety, in this case quantitative and qualitative data sets, are indicated by the blue coloured elements of the diagram. The blue arrow is the vector indicating that quantitative data is embedded in qualitative data (QUAN/Qual). The research methods used in this study and are indicated in the green scale in the diagram. The yellow markers distributed across the green scale indicates where each method was placed inside the thesis structure: systematic review; controlled agronomical

trials; farmers' surveys and interviews with key stakeholders. The interpretation of the qualitative data followed content analysis whereas for the quantitative data descriptive statistics was used.

Figure 5 - Research design diagram and the Mixed Methods Sequential Explanatory Design Elements.



Source: developed by the author (2022).

The justification for such a research design is due to the nature of the investigated phenomena. For a start, the systematic review helped to cluster information on how vitality had been assessed in agricultural research, selecting parameters and definitions to be compared with the data obtained from the other methods used in this study. Next, the controlled trials which are based on deductive statistical analyses; hence the etic approach is applied to establish a theory and hypotheses that are then tested through the collection of data. In addition, the survey collected evidence on agronomic, ecological and sociological aspects of farmers who use Homeopathy and DHDs in agriculture. This information complemented the more in-depth analysis enabled by the interviews with key-stakeholders within a qualitative and phenomenological research approach.

The mixed methods research approach is essential when combining numbers and stories, when the research aim is to explore and understand as well as test and measure (CRESWELL, 2013). In this sense, the qualitative approach used in this research is

influenced by phenomenology (SMITH, 2013) focusing on heuristic inquiry (SULTAN, 2018) and grounded theory. The grounded theory used here focuses on the concepts proposed by Charmaz (2006), where the research conducts simultaneously data collection and analysis in a cyclical process; requiring a research-data-reflection, understanding changes over time that continually informs the next steps or the return to previous steps of the research.

The phenomenological approach is crucial to this research because phenomenology expresses that comprehending the meaning of a phenomenon can only be understood subjectively and intuitively grasped in its essence, particularly focusing on interpretation phenomenology (PATTON, 2014). Within phenomenology, the heuristic inquiry refers to a process of internal research whereby one discovers the nature and meaning of experience and develops methods and procedure for further investigation analyses (MOUSTAKOS, 1990). Heuristics is about living relationships with phenomena and people (SULTAN, 2018). It's a methodology deeply rooted in tacit knowledge that leads to a deeply subjective and creative connection between the researcher and phenomenon (SELA-SMITH, 2002).

The disciplines guiding this hybrid research are multiple: Ecology, Agronomy, Agroecology, Sociology and Psychology which helped to study the agricultural practices, as well as the human experiences, gathered from the interviewees, surveys and experiments. This research was conducted both in Brazil and in the UK. Coming from natural sciences background at UDESC university (BR), it was particularly intensive the immersion in subjects such as sociology and psychology, experiencing a learning curve that was only possible due to a co-tutelle research program with Coventry university (UK). The researcher ascertain the importance of encompassing different disciplines and different sources of knowledge as well as the multi-level and multi-scale character of these subjects. Following on from the recognition of the complexity of dynamic systems, this research adopts a holistic and inclusive approach that has the potential to increase the resilience of food systems (REID et al. 2015).

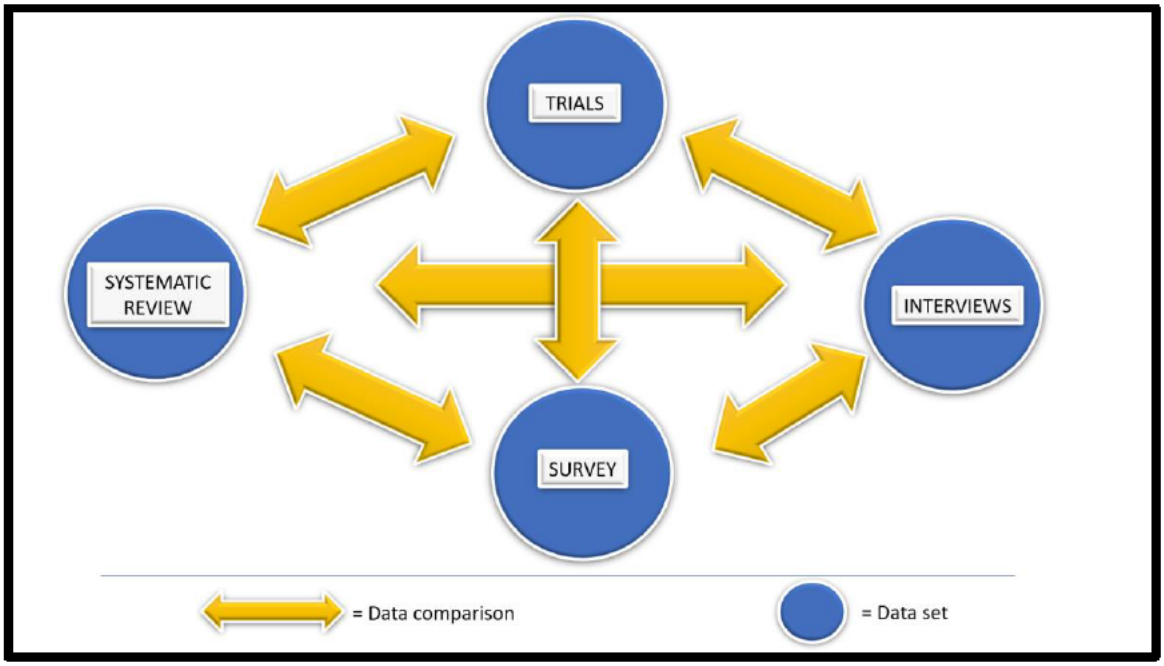
According to Creswell, (2013) one way to better comprehend the results yielded from mixed methods research is by doing theoretical saturation and data triangulation (figure 6).

This research used data triangulation, because such method enables the comparison between different sets of information. Furthermore, as Guion et al (2011) explains, triangulation leads to synergy, enrichment and complementarity of data,

although it can be very costly in terms of time, money and energy as triangulation results in large amounts of data requiring much time on analysis. However, the benefits of triangulation include increasing confidence in research data, creating innovative ways of understanding a phenomenon, revealing unique findings, challenging or integrating theories, and providing a clearer understanding of the problem (THURMOND, 2001).

Each data set could have limitations and, triangulation is used here to help overcome these limitations, to establish a connection between the data sourced from different methods and knowledges (FORAN et al. 2014).

Figure 6 - Data triangulation and theoretical saturation amongst complementary forms of data used in this study.



Source: developed by the author (2022).

The research used data triangulation with the help of in NVivo® as well as on paper, creating flowcharts and diagrams to organize and make sense of the research topics, as well as engaging in regular discussions with the research team and other researcher-peers.

There are no set of perfect and complete methods in research (NIGHTINGALE, 2003). However, the most important factor is how the methods are used to ask questions and how the results are interpreted (SHEPPARD, 2001). According to Munuya et al (2010), combining qualitative and quantitative research encourages creativity and

enriches the understanding of problems being investigated to get a deep understanding of it. Particularly, this research approach offers a reliable basis to explore ways of strengthening linkages and improving the sharing of agricultural knowledge and information (HOFFMANN, 2007).

In the same sense, Knox (2004) points out that combined methodologies are best used in a complementary way to ensure a holistic view of the investigated phenomena. This research design offers the possibility to identify opportunities to improve a knowledge and information system, such as the one being explored in this research.

1.9. Thesis structure

The study is divided into six chapters: 1, Introduction to the thesis; In the chapter; 2 a systematic review was carried out on the topic of vitality in agriculture. This chapter helped to identify and cluster research data on the topic. It supported the choice of parameters to assess crop vitality regarding the use of homeopathic preparations (DHD) in agriculture in the next chapter (chapter 3). It also it helped to source information on vitality to be contrasted and compared with the information from the survey and interviews; (b) In chapter 3, the results of the agronomical experiments testing homeopathic preparations will be presented. The contributions of homeopathic preparations (DHD) to the sustainable management of strawberries (*Fragaria* × *ananassa*), aiming for the replacement of agrochemicals will be examined; (c) The chapter 4 explores the results yielded from a survey circulated among farmers who use homeopathy and dynamized high dilutions. The web survey was designed to grasp information on user profiles – which kind of farming approach is using DHDs; what are users' experiences in using DHDs; what are the main DHDs they have been using. The survey helped to deepen understanding of the main benefits and challenges farmers are facing in using DHDs and to observe how the use of DHDs is influencing their ways of farming and how farmers defined vitality; (d) The chapter 5 dwells on data from interviews with key stakeholders (researchers, farmers and advisors) purposing to gather descriptions of the lifeworld of the interviewees with respect to interpretation of the meaning of vitality and the use of homeopathic preparations in agriculture. The interview results helped to highlight the roles and relationships between different actors, what they do, how they learned, and how they shared ideas and experiences on using homeopathy

in agriculture and how they experience vitality in the agroecosystem. Ultimately, the data from interviews allows to characterize a personal world view and work experience, understanding how the interviewees encounter the phenomena of homeopathy in agriculture as a means to promote crop vitality; (e) Chapter 6 is the general discussion in which the research results are reviewed and the implications of using homeopathic preparation in agriculture as well as the role of vitality could play in associating integrated scenarios of research and farming strategies towards sustainable agriculture are proposed.

2. A SYSTEMATIC REVIEW OF THE CONCEPT OF VITALITY IN AGRICULTURE

2.1. ABSTRACT

Vitality is a complex and multifaceted phenomenon with a pluralistic nature and philosophical implications. It has been scarcely addressed in agriculture, sometimes through metaphysical explanations but also by a series of correlated terms that express vitality through biological and sociological manifestations. The objective of this research was to identify definitions and comprehend how vitality was assessed in agricultural research from scientific papers from 2002 to 2022. In addition, to examine the identified concepts to select parameters to be used in the controlled trials as well as to source information to be contrasted further with the data from the survey and interviews chapters, aiming to get a better comprehension of the phenomenon of vitality. To do so, a systematic review was carried bout using the systematic review protocol PRISMA. Overall, around 21 scientific terms addressing vitality in agriculture were identified. Out of 2153 papers yielded, 74 papers met the robustness criteria to be analyzed in this review. Around of 39% were ranked as "A" (all robustness criteria met), 54% were classified as "B" (one of the robustness criteria was missed) and 7% were ranked as "C" (more than one of the robustness criteria was missed). Brazil, China, Canada, France and Germany, were the countries who had the biggest percentage of papers ranked as "A". From the higher ranked (A) studies, the terms plant vitality (19%), ecosystem vitality (14%), seed vitality (9%) and crop vitality (7%) composed the biggest number of papers within that category. There was a significative increment of 79.72% in the number of publications using the term vitality in agriculture since 2017. From this number, China (17%), India (7%), France (7%), Germany (6%), Poland (6%) and Brazil (6%) were the countries who had more publications in the period.

KEYWORDS: Vitality; Agriculture; Publications; Vitality indicators; Systematic review

2.2. INTRODUCTION

This chapter is initiated with a initial set of definitions of vitality. From the literature, vitality emphasizes manifestations towards health, harmony, and the capacity to be alive

(NORMANDIN et al 2015), it is interconnected to resilience, growth, development, functionality, and life stimulation in a harmonious way (NORMANDIN and WOLFE., 2013).

From the homeopathic philosophy, vitality is entangled with a vital force principle defined as an autocratic, dynamic, immaterial action-principle that governs physical life, that integrates the entirety of the organisms and governs all physiological phenomena being distinct from the body and the spirit (HAHNEMANN, 1842). The imbalance in this vital force could potentially generates inharmonious manifestations facilitating the appearance of pests and diseases (BETTI et al., 2009).

Outside the philosophical implication, assessing vitality is perhaps one of the biggest challenges of addressing the term in scientific investigations, mainly on natural sciences, and this issue has fomented debate between the west and east therapeutic traditions over the methods used to do so (GULMEN, 2004; TEIXIERA, 2021). Similarly, in agriculture, the ways to assess the health and vitality of the agroecosystem are debated between industrial and agroecological farming approaches (DÖRING et al., 2012).

In this sense, more information on the topic of health and vitality of the agroecosystem is needed to keep an up-to-date dialogue between research and agricultural practices towards sustainability and its benefits for the society (DÖRING et al., 2012). The objective of study is use a systematic review to answering the question: Has vitality been used in agricultural studies as a research attribute in the last twenty years?

2.3. METHODOLOGY

2.3.1. Systematic review: a method to find and cluster information

A systematic review refers to the research method of finding and bringing together the available information about an effect or subject. By combining results from several studies, it is possible to assess an overall outcome (DAVIS et al., 2014). In addition, this analysis helps to clarify how a field of research stands, determine if an effect is constant across studies, and identify what further research is required (HARDEN and THOMAS, 2005).

A good systematic review should have a focused question, clear inclusion and exclusion criteria for the papers, and a transparent search strategy. It should identify papers which fit under the review criteria, assess the quality of the studies, synthetize the study's results and address the review limitations (HIGGINs and GREEN, 2011). Davies et al (2014) suggests the overall structure of the systematic review should follow:
A formulated focused question, comprehensive search and inclusion of studies, quality assessment of studies and data extraction, synthesis of study results and interpretation of the results and reported writing.

There are different strategies to communicate the results of a systematic review, however, Koricheva et al. 2013 explain that one of the most used ways to report the data from a systematic review is by using a traditional narrative review. Such an approach focuses on describing and contrasting results found in the systematic review, in order to understand the causal processes behind the phenomenon under study (SLAVIN, 1987; KIRICHEVA et al.,2012). In this way, a systematic review is an adequate method to locate, evaluate and synthesize evidence.

This systematic review selected papers from 2002 to 2022 and included exclusively peer reviewed papers, both empirical trials as well as literature reviews. The search was conducted in English and focused on papers available on the academic research platform Scopus®.

The systematic flow of this review used the PRISMA - Preferred Reporting Items for Systematic Reviews and Meta-Analyses principles (MOHER *et al.* 2009). The PRISMA has been commonly used to carry out systematic review in agricultural research (DOEHRING and SUNDRUM, 2016; MATHIE and CLAUSEN, 2015). According to Liberati and colleagues (2009), the PRISMA framework ensures a transparent and complete reporting of systematic reviews and meta-analyses.

Figure 7 illustrates the PRISMA process flow of this research, and the explanation for step-by-step methodology is given next.

Identification

A search was conducted using the database Scopus®. Only journal articles were included. The searches were carried out based on the combination of word *Vitality* plus another key word – Agriculture, Farming or Food. The search collected papers that contained at least two of the words on their title, keywords or abstract.

Screening

The records were initially screened to include only peer-reviewed empirical trials and literature reviews published in academic journals papers from 2002 to 2022, aiming to represent an up-to-date and contemporary literature. Books, abstracts and summarised reporting for conferences were also excluded. In addition, any paper that was not directly linked to agriculture was excluded.

- Criteria to include publications

Only peer-reviewed empirical trials and literature reviews published in academic journals papers. The data within the scientific studies should address, explore and measure vitality; the research outcomes (positive or nil/inconclusive or negative) should be posed clearly.

- Criteria to exclude publications

Books, abstracts and summarised reporting for conferences were excluded. In addition, any paper that was not directly linked to agriculture was excluded.

Eligibility

After the screening, a two-stage sorting process was carried out to determine each paper's eligibility.

Sort 1: Articles retrieved were assessed via a thorough scan, analysing publication title, key words and abstract to determine relevance to the research questions.

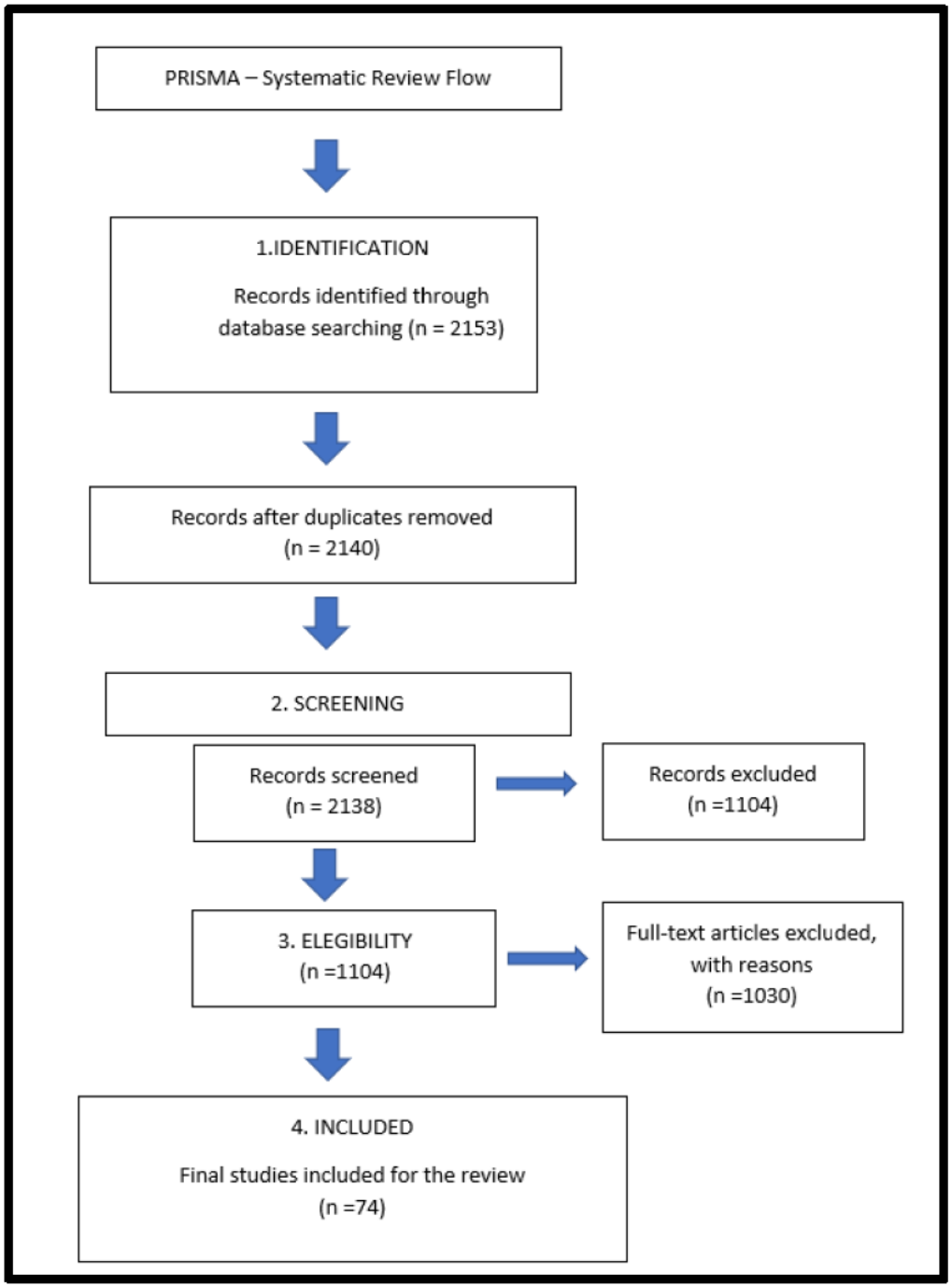
Sort 2: All articles were categorised into 2 types:

1) Empirical research
2) Literature review

These two categories, empirical trials and literature reviews, were further reviewed in more detail for robustness. The robustness criteria were based on those used on systematic reviews in agriculture by Fayet at al (2022), Cidón et al (2021), El Chami et al (2020) and Petticrew (2001) and considered as robustness criteria:

- For empirical research: a) peer reviewed and clearly described methodology; b) minimum of 2 replications per trial; c) statistical analysis at p=0.05 or less.
- For literature review: a) peer reviewed and detailed methodology; b) clear justification and problematization; c) clear study results, outcomes, and limitations.

Figure 7 – The Systematic Review Flow and its elements used in this study.



Source: developed by the author (2022).

Any complete paper that met all criteria for its type were classified as ranking 'A', whereas papers that missed one criterion were classified as ranking 'B", and finally if two criteria were missed, it was classified as 'C". If none of the criteria were met, the paper

was excluded. Only publications where the full text was available in English were considered.

Parameters for Analysis

Scientific term used to assess vitality

Robustness criteria (A, B, C)

Geographical location

Publication Date

Result ('Positive' or 'Nil/Inconclusive' or negative).

2.4. RESULTS AND DISCUSSION

In total, the systematic review yielded 2153 publications that went through a sorting and exclusion process. After a thoroughly analyses following the PRISMA process, 74 papers were selected for the final analyses.

2.4.1. Identification of terms addressing vitality

Overall, the systematic review identified 21 scientific terms used in empirical and literature reviews addressing vitality in agriculture (table 3). The terms plant vitality (19%), ecosystem vitality (14%), seed vitality (9%) and crop vitality (7%) composed the biggest number of papers (figure 8) addressing vitality in agriculture.

Table 3 – Scientific terms identified in the systematic research

Used Term	Number of studies	Empirical	Review
Animal vitality	5	4	1
Cell vitality	2	1	1
Colony vitality	3	3	0
Community vitality	2	2	0
Crop vitality	3	3	1
Ecology vitality	2	1	1
Economy vitality	3	3	0
Ecosystem vitality	10	5	5
Organism vitality	1	1	0
Peasants' vitality	1	0	1
Plant vitality	19	14	5
Pollen vitality	1	1	0
Rhizome vitality	1	1	0
Roots vitality	2	2	0
Rural vitality	3	0	3
Seed vitality	6	5	1
Seedling vitality	1	1	0
Soil vitality	3	3	0
Territorial vitality	2	2	0
Urban vitality	3	3	0
Vegetation vitality	1	1	0
Total number (21)	**74**	**56**	**18**

Source: developed by the author (2022).

2.4.2. Origins of the publications: which countries are researching vitality?

Overall, the publications came from 31 different countries. It's possible to highlight that China (17%), India (7%), France (7%), Germany (6%), Poland (6%), Brazil (6%) were the countries that had more publications. If data is grouped by regions, Europe makes around of 58% of the publications, Asia accounts for 25% (Russia included here), Middle East (5%), South America (7%), North America (5%). There were no papers from Africa or Oceania.

It is interesting to notice how China and India, both countries with big cultural-philosophical vitalist influences (GLUMEN, 2009) are two of the countries with more publications on vitality in agriculture. It is also noticeable that France, Germany, Poland

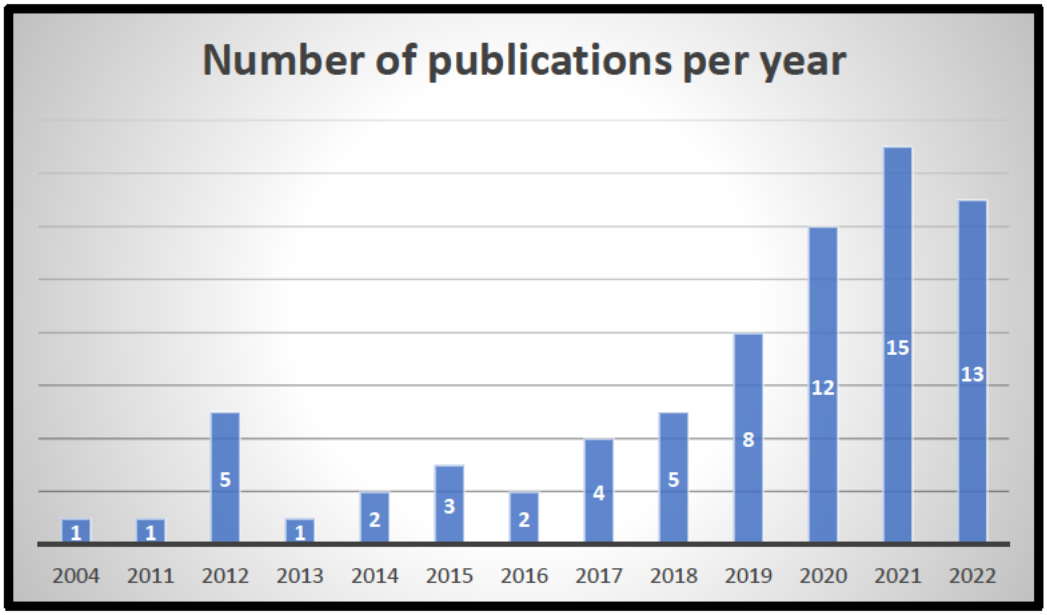
and Brazil identified here also as main publishers on vitality in agriculture, are listed on the top 15 countries which have experienced increment on their areas of biodynamic farming - a farming method heavily influenced by vitalist and anthroposophical philosophies - in the last five years (PAULL and HENNING, 2020).

2.4.3. Number of publications per year.

There has been a significant increase in the number of publications addressing vitality in agriculture, particularly from 2017 onwards (figure 8). The first publication identified in the period analysed (2002 to 2022) was from 2004 and, from that period until 2016 the number of publications were less than five per year. However, from 2017 a significative growth of 79.72% in the number of publications was experienced in the period, reaching a peak of 15 publications/year addressing vitality in agriculture.

The growth in the number of publications on vitality in agriculture could be related to a general growth on the number of research done on agroecological farming across the globe (PRETTY et al., 2018; TITTONELL et al., 2020). This growth in publications on agroecology is stimulated by an ever-growing interest on agroecological farming and organic food consumption due to the benefits that this farming method and food can offer to people (LIMA et al.,2020).

Figure 8 – Number of publications per year addressing vitality in agriculture founded in the systematic review from 2002 to 2022 period.



Source: developed by the author (2022).

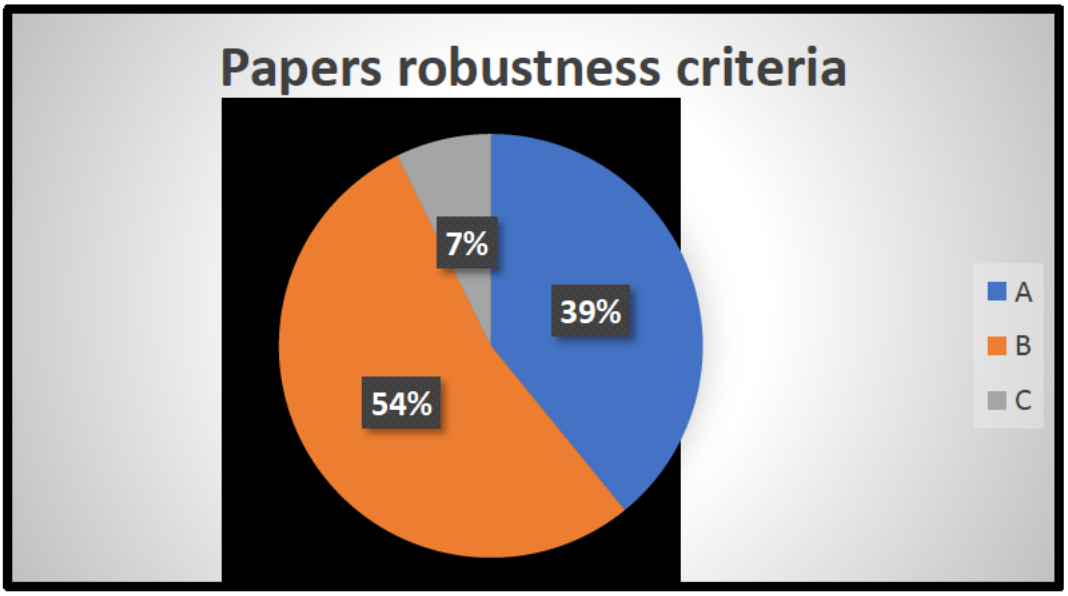
2.4.4. Papers' robustness

After analysing the papers for their robustness (figure 9), it was possible to assess that 54% of the papers were classified as "B", meaning that most of the robustness criteria were achieved. The main reason for this classification was that most of the empirical studies had only one repetition of their trials. As seen in the table 3, most of the papers yielded for this review were empirical studies, therefore explaining the bigger number of "B" studies.

On the other hand, over 39% of the papers were classified as "A" meaning that all the robustness criteria were achieved. Most of this percentage is made of papers addressing plant vitality and crop vitality and is complemented by robust literature reviews on ecosystem vitality.

Only 7% of the papers were classified as "C" meaning that more than one the robustness criteria were not successfully addressed. In this case, the literature review papers were the main causes for this classification. The reason for that is because even though the there was a clear theoretical background, the results and outcomes presented slightly diverged from the studies inquiries, thus making the papers' conclusions and outcomes vague.

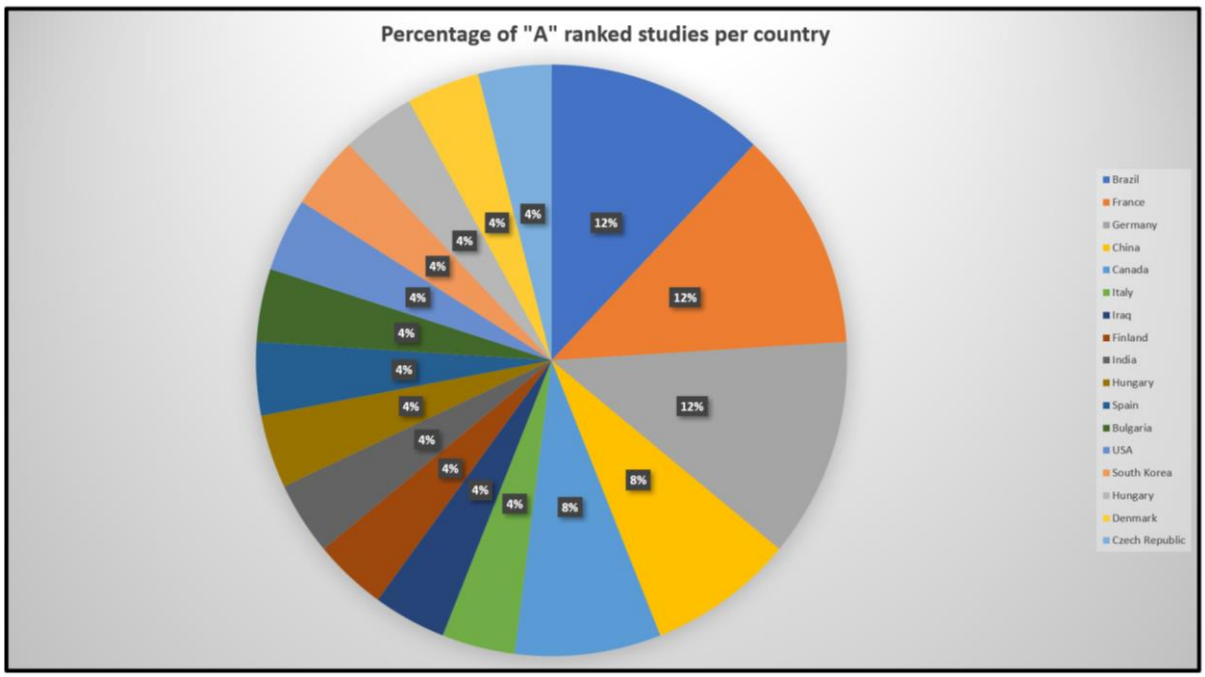
Figure 9 – Robustness criteria from studies addressing vitality in agricultural research found in the systematic review within the period of 2002 to 2022.



Source: developed by the author (2022).

The figure 10 illustrates the cross correlation between the geographical spread with the robustness. The biggest percentage of the papers ranked as “A” comes from Brazil, France and Germany, followed by Canada and China.

Figure 10 - Countries with “A” ranked publications in vitality in agriculture



Source: developed by the author (2022).

2.4.5. Examining terms and selecting parameters

As part of the narrative method to explore systematic review results (KORICHEVA et al. 2013), this study examined data from the papers selected for the final analyses, looking into the terms, definitions and methods. In this way the research could better comprehend how the phenomenon of vitality in agriculture and put it into context to triangulate this information with further data collected from the other methods.

2.4.6. Vitality – a plurality of definitions for the phenomenon

It was intriguing to find out how vitality has been addressed and measured in agriculture, albeit not to a great extent based on the number of papers reviewed. The discussions on vitality orbit around biological and social effects. In general, the results

elucidated different sets of characteristics, that each express an optimum state of existence or manifestation, no matter whether for a biological system (seed, plant, animal or ecosystem) or a community. This optimum/harmonious positive feature could only be comprehended if described in terms of vitality, due to the meaning that the term implies. Here I'll discuss the data going from micro to macro definitions of vitality.

Cell vitality - (2 studies)

This term was used in two studies. Huang et al (2022), use the term cell vitality to describe the capacity of cells to multiply and perform their metabolic functions appropriately. The authors use metagenomics, metatranscriptomics and gene sequencings, to understand bacterial metabolic activity, and when referencing the optimal development and activity of the bacteria studied (*A. pasteurianus, L. acetotolerans, L. helveticus, Ac. Jinshanensis),* they did so use the concept of cell vitality.

In contrast, Teixeira et al (2020), argue that cell vitality means the capacity of the cell to perform its physiological functions which is a property maintained by the vitality or vital force of the cell. This was the only paper that used a metaphysical background to relate the biological cell functions. The authors suggest that the vital force is intrinsically linked to the genome structure and manifestation:

> "*The vital force and the genome are the fundamental substrates for the emergence and maintenance of life, vitality of living beings; the vital principle is responsible for maintaining the balance of the body's sensations and functions, just as the genome stores the biochemical information which will produce the proteins responsible for maintaining vital processes and developing organisms; diseases generally occur due to dystonia of the vital principle, as well as genomic changes which promote disease; the vital force and the genome are both affected by the influences of the same external and internal etiopathogenic factors, among others…the vitality here is expressed in the telomeres and telomerase process*" (TEIXEIRA et al, 2020, p 4).

In this case, vitality is addressed as a force that manifest itself through the physiological cell function and the activity of the telomerase enzymes may be used as a biomarker of the organic vital force state due to functional physiological. The authors base their argument is on the findings of research by Blackburn et al (2009) who received a Nobel Prize for finding that telomeres and the telomerase enzyme are responsible for the chromosomic and genetic information integrity.

Finally, the authors explain their analogies:

> "*We highlight that the vital force and chromosomes are the substrates for maintaining the phenomenon of life, and the integrity of the organic vital force and the chromosomal endings (telomeres) are responsible for cellular vitality, longevity and maintenance, whilst cellular senescence, biological aging and the disease process result from vital imbalance and alteration in telomeres* (TEIXEIRA et al., 2020, p 8).

In this hypothetical context, the telomeres would reveal the organic vital force state.

Organism vitality (1 study)

One study addressed vitality using the term. Polcyn et al (2019), used arbuscular mycorrhiza to help maize plants to overcome drought impacts. For the authors, the organism vitality will be reflected in the organism's resilience in the face of stress and also by the bonding relationships created by the crop with its surroundings and in this particular case, establishing symbiotic connections. The authors relate organism vitality to chlorophyll content, nutritional concentration of leaves, photosynthetic and transpiration capacity, and crop senescence.

The authors conclude that ecological dynamics such as symbiotic associations are fundamental for plants to make better use of nutrients and water. It's possible to relate the organism vitality to other reviewed terms such as plant vitality, ecosystem vitality, seed vitality and others. Organism vitality is interconnected here to resilience, growth and development.

Seed vitality – (6 studies)

Six studies used the term Seed Vitality. In common, all these authors used the term to describe the seed germination time, seedling growth, morphogenetic features (development of shape and structures), stress resistance and its capacity to become a full established seedling. As highlighted by the authors, this latter phase is critical because the seed is vulnerable to environment stress. Other than that, according to all the authors, seed vitality expresses the life potential of that seed to become a mature productive plant. All studies use cereals (maize, sorghum wheat, barley or oats) in their studies.

The approach to measure seed vitality varies though. Shihab and colleagues (2020) studied the influence of gibberellic and salicylic acids in seed vitality. These

authors use a seed vitality index (composed of germination rate and speed, seedling root and first leaf length, shape and development of seedling). They verify a positive influence on germination and seedling development through seed treated with gibberellic and salicylic acids. Similarly, Bláha et al (2013) use a seed vitality index to study cereals (wheat, barley and oats) from organic and conventional origins. They couldn't verify differences in the seed vitality index between the two origins. According to them, the use of a seed vitality index is considered common practice in agriculture, but often the results are reported in terms of vigour rather than vitality.

A different approach is taken by Pang et al (2020) who use hyperspectral image techniques to estimate maize seed vitality: the image technique was efficient to predict germination rates in a short time (3 hours when compared to traditional seed germination tests of 72hrs to one week), but the system was not able to assess seed resilience against stress and others. However, the costs of the software and use of deep learning programmes were higher when compared to germination chambers commonly used to perform those estimations. Al-Dawoodi and colleagues (2022) study the effects of storage time (1,3,5 years) on sorghum seed vitality and used nanoparticles of iron (0, 100, 200 and 300 mg $^{L-1}$) to stimulate seed germination. Their results demonstrate that seeds stored for one year and treated with nano-iron at 300 mg L-1 had higher germination rates, radicle length, plumule length and fresh and dry weight of seedling.

A slightly different route is taken by Ciacka et al (2020), who review the influence of aging on seed vitality, adapting the free radical theory of aging (documented for animals) to seeds. The authors explain that reactive nitrogen species (RNS) participates in metabolic process such as protein modification (posttranslational protein modifications) and modulation of reactive oxygen species metabolism, which are involved in physiological processes in plants, including seed formation, maturation, dormancy, and germination. Here, the authors argue that assessing seed vitality by means of RNS would be interesting, particularly on seedbanks and warehouses because the method allows a close correlation with seed lifespan (typical length of time that a seed survives) and longevity (length of time that seeds can remain viable) and that the use of nitric oxide (NO) could be used as a means to mitigate the negative aging effects over seed lifespan and longevity. Despite the potential, the authors make clear that their proposal should be investigated further.

Rhizome vitality – (1 study)

This term was cited by one paper Zsiláne-André et al (2019) study the influence of effects of six pre-storage rhizome treatments on *Canna* × *generalis*. The authors select bud numbers, disease incidence of rhizome, number of sprouted plants, leaf numbers and plant height as rhizome parameters. Similarities can be observed with the studies addressing plant vitality.

Seedling vitality – (1 study)

Nasim et al (2019), was the only study addressing the term to be used to describe survival rate of grape seedlings. The authors used molecular information to evaluate viability and survival rate of dormant seedlings before transplanting. Their focus is to correlate the expression of housekeeping genes (HKGs) which are typically constitutive genes, known as plant, live related genes, required for the maintenance of cellular functions, expressed in all cells of an organism for cellular survival (cell wall structure and primary metabolism). The results reveal that HKGs expression indicates *vitality and survival of plants, and* a lower expression is associated with lower vitality and survival rate. They also concluded that the DNA and RNA quality can superficially determine seedling qualities.

When contrasting this data with the that on cell vitality, it's possible to discern the theoretical correlation between gene expression and vitality. The authors even state that the genes are known as 'plant life related genes' – genes associated with life force. However, the authors prefer to discuss the cell's natural expression.

Pollen vitality – (1 study)

One study by Radice and colleagues (2018) used the term. The authors studied flower development and pollen vitality in *Moringa oleifera* cultivated in a temperate climate. The authors looked at flower morphology and anatomy (number of flowers and flower structures), as well as microsporogenesis and viability of pollen grains, using fluorescent and light microscopy to collect data. They observed that cold temperatures influenced the number of flowers produced as well as their structure. Pollen vitality was associated by these authors with the maintenance of fertilization levels, or in other words, the capacity to become fruit.

Root vitality – (2 studies)

Two papers used the term root vitality. Zhu et al (2018) developed a study with soy, and Cseresnyès et al (2018) with maize. Both papers referred to root vitality as comprising root morphologic characteristics (growth, root length, surface) and root system colonization by microorganisms, however Cseresnyès et al (2018) simultaneously measured leaf chlorophyl content and stomatal activity. Both authors argue that root morphology and physiological activity directly influence the absorption area and capacity of the root for water and nutrient absorption. This set of characteristics are seen as indicators of root vitality.

Moreover, both studies verified that the presence and abundance of microorganisms are essential for plants to overcome environmental stress, absorb water and nutrients at a more efficient rate.

Plant vitality – (19 studies)

The studies using the concept of plant vitality were the most numerously identified in the systematic having the 75% of the papers were classified as robust ("A"). Overall, the studies recognized an association linking plant vitality to plant growth, canopy development, ecological structures and crop health.

Gräf et al (2022) studied the use of greywater (domestic water without urine and faeces) in comparison to municipal tap water to irrigate sycamore (*Acer pseudoplatanus*) and small leaf lime (*Tilia cordata*). The authors assessed plant vitality, measuring plant growth, including leaf area, number of leaves, average leaf area and annual growth. Also, the chlorophyll content was determined using both *SPAD* measurement and image analysis aiming to identify necrotic leaf parts. The results revealed that grey water had a negative effect on the plant's growth boosting leaf necrosis. İşçi et al (2019) also evaluated the effect of water (hot water treatment) on dormant cuttings of *Vitis vinifera* rootstocks. They observed that hot water significantly helped to break the dormancy of the cuttings faster than normal temperature water. For them, plant vitality was expressed as the quality of root development and health of these cuttings.

He and his collaborators (2022) studied the potential of mapping crop areas using fractional green canopy cover (FGCC) assessment of management practices designed to promote crop productivity whilst maintaining environmental sustainability. The mapping method (FGCC) measured the canopy development, light interception, and

evapotranspiration of corn fields. The authors argue that FGCC was able to measure the influence of the management used during that season. Here, plant vitality is associated with plant development and the plant-soil relationship.

Malk and colleagues (2021) reviewed biostimulant uses in agriculture. The authors explored how biostimulants, for example plant-based, fulvic and humic acids and others, stimulate a series of metabolic and biological responses in plants rather than specifically focusing on solving one issue such as disease or abiotic stress. According to the authors, biostimulants are essential tools to catapult agriculture towards sustainability, reducing the use of chemical fertilizers and pesticides and ultimately, promoting crop resilient plants and better use and assimilation of nutrients.

A similar approach was used by Kocira and colleagues (2018) who evaluated the effect of plant extracts (40 different plants) on germination capacity and surface contamination of spring barley. They found that plant extracts (particularly *Marrubium vulgare*) enhanced germination and diminished the seedlings' contamination by harmful microorganisms. They conclude that the plant vitality (vitality and healthiness) of grains were enhanced.

Ogar et al (2015) studied the extent to which the inoculation of microorganisms (arbuscular mycorrhizal fungi and N fixing bacteria) could help plants (they used *H. pilosella* L. and *M. sativa* L as plant models) to overcome environmental stress conditions (soil contaminated with Pb and Zn). They described plant vitality as the capacity of plants to overcome such environment stresses and still have the capacity to develop. The authors used a plant performance index to express plant vitality. Such an index was composed of leaf chlorophyl content, biomass (root and aerial part dry mass) and root colonization by the inoculated microorganisms. They concluded that microorganism inoculation (bioremediation) can help plants to overcome soil contamination.

Boroviona et al (2012) included the pathosystem dynamic (incidence x severity) into their interpretation of plant vitality, and for these authors, plant vitality was expressed as the resistance and susceptibility of the apple trees n being attacked by apple tree complex disease. Rawat et al (2014) associated plant vitality with the plant's composition and the potential benefits they can bring to human health.

Further, Cekstere and colleagues (2021) considered the relationship between yield and fruit quality in tomatoes as a representation of plant vitality.

Sugár et all (2019), also used the term plant vitality for measuring flag leaf chlorophyll content and vegetation index (leaf area) to estimate spelt wheat production.

In the same way, Lindener et all (2017) used mapping and vegetation index (percentage of soil covered by plants, plants mosaic diversity and chlorophyll content) to express plant vitality.

Two reviews analyzed the issues of industrial agriculture and argued that this approach is responsible for diminishing plant vitality, meaning plant resilience, production, adaptability and its ecosystem role. Ashkenazi et al (2020) reviewed how the vitality of Bedouin orchards was promoted in arid areas. They describe how these people used complex management strategies of the land to mitigate climatic changes and promote environmental stability, while promoting the plant's vitality, pointing out the capacity of their fruit trees to thrive in arid areas.

Likewise, Gerber and Hiernaux (2022) criticize what they claim to be the current view of plants as machines, and how this conception has led mainstream agriculture to lose its connection to nature itself. The authors' claim that this conception based on rhetoric centred on breeding, biotechnology, and production separates man from his/her innermost and subjective connection to the land and how this understanding has legal and ethical consequences. Ultimately, the authors propose that new models of agriculture are needed, particularly ones that create different sets of values and relationship between, plant, man, and the environment they share. They argue that promoting plant vitality is to promote humankind vitality.

Crop vitality – (3 studies)

The term crop vitality appeared in three papers. Synonymous with plant vitality, crop vitality for all the authors meant crop growth and development, canopy development, vegetation composition, crop diversity, and crop resilience in face of environmental stress. Liebisch et all (2014), attributed crop vitality to leaf chlorophyll, carotenoid, anthocyanin, and water content, leaf greenness, biomass, and leaf area index. In addition, the authors propose the use of the Airborne Prism Experiment (APEX) imaging spectrometer to measure the growth and vitality status. According to them, this tool could help to enhance resource efficiency in agriculture.

Del Mar Algucil and collaborators (2012) linked crop vitality to resilience and adaptation as the authors presented data of a 43-year study which looked in the influence of treated urban wastewater on the arbuscular mycorrhizal fungi, diversity of soil microbial activities and production of an orange orchard. The authors found that no

negative effects were observed on crop vitality and productivity and that the ecosystem resilience influenced the selection of microorganism species present in the orchard.

Similarly, Taqdees and colleagues (2022) linked crop vitality to crop resilience. These authors investigated the potential use of biochar enriched with nanoparticles of Zn to solve soil salinity stress. The enriched biochar helped the seedlings of radish to overcome this stress. The authors associated their results with support for natural crop vitality which they measured by means of plant fresh weight, germination and concentration of biochemical parameters.

Soil vitality – (3 studies)

Three papers used the term soil vitality. These authors (Gagnarli et al, 2021; Wang et al, 2022; Song et al, 2022) indicated soil vitality as being associated with soil quality and functionality, biological diversity indicators (plant and microorganisms), management strategies (soil cover, mulching, cover crops), physical structure and nutritional soil profile. Moreover, the authors point to this set of characteristics as being key factors in reducing soil – physical, biological, and functional- degradation. They suggest that soil vitality could be achieved by agricultural practices as well as use of bioremediation (using plant and other amendments).

Soil vitality is also considered to be a key concept when taking actions around climate change. The authors argued that land management focusing on soil quality and functionality are essential for C sequestration, water maintenance and production of high-quality food and enhancement of biodiversity. They criticize the simplification of the agroecosystem as being the strongest driving force causing soil degradation.

Gagnarli et al (2021) used an index called LUC (land use change) to assess soil vitality in vineyards. The authors were able to monitor soil biodiversity (for 2 years) which enabled the detection of biodiversity hot spots, as well as areas susceptible to changes, helping to accomplish successful ecosystem management. Whereas, Wang and colleagues (2022), studied soil phytoremediation (white clover cover and mulching) and its effect over microbiology diversity and functionality in apple orchards. These authors used metagenomic analyses and biological techniques to measure microbiology activity. After 14 years, they concluded that cover crop and mulching enhanced the soil biological diversity and functionality, having as a consequence stable soil, more resilient and productive apple trees.

Very similar was the work of Song et al (2022), who looked on how exogenous substances such as river sediment, lake sediments, straw, algae, submerged plants, and livestock manure influenced soil properties. These authors analyzed changes of soil water soluble organic carbon (WSOC) and soil dissolved organic matter (SDOM) in the process using the above listed amendments. They observed that river sediment and straw, algae, livestock manure can change the content of SDOM and WSOC in the soil, positively influence soil vitality, improving the structure, composition, and quality of the soil.

Animal vitality – (5 studies)

Five studies used the term animal vitality, comprised research with piglets, hens, calves, lambs and marine hydroids (*Hydractinia echinate).* Regardless the kind of animal studied, animal vitality was taken to mean survival rates, or number of animals that survived or completed their development to the next stage of the production chain. All the studies used a survival/vitality index (that resembles the one used for seed vitality) adapted to each animal category.

Tschink at al., (2021), studied the population dynamics of *Hydractinia echinate,* a marine organism, aiming to understand possible impacts of warming climate and the rising seawater temperatures on marine ecosystems. The authors counted the *Hydractinia echinate* colonies via morphometric analyses (number of organisms and shape of colonies) as indicators for individual growth performance. The authors demonstrated that ocean warming may have major impacts on biodiversity and ecosystem function, explaining:

> "*We currently lack a mechanistic framework for integrating the effects of multiple interacting physiological functions on the vitality and growth performance of marine invertebrates" (2021,p 12)*

Condon et al (2021) investigated genetic and non-genetic factors associated with health and vitality on calves. The authors collected data of health (number of suspected calves having Scur (incompletely developed horn) and pneumonia, where 0 = no occurrence, 1 = one occurrence, or 2 = more than one occurrence) and the birth rate (which was scored on a scale where 1= very small and 5= very large). There was no discussion regarding implications of such vitality parameters, but on the other hand, in

this study, vitality was correlated to the capacity of the calves for not having a disease and also for the size they were born. At the end, the authors verified a positive correlation between size and the incidence of disease – bigger calves (vigorous) were less likely to succumb to Scur or pneumonia.

Comparably, De Sousa et al., (2022), analyzed the birth rate in lambs' survival but this time, in the postpartum period (up to 72 hours), while Schild and colleagues (2020) evaluated neonatal piglets' mortality (up to 72 hours) in outdoor organic production. Both studies used similar birth indices that considered how long the animals lived until they overreached a critical period but also, qualitatively described the animal. Finally, Grezilov et al (2015) studied the effect of herbal mixture supplemented to chickens (form hatching to 52 weeks of age). The authors here correlated animal vitality to growth performance, egg production and overall health conditions. The authors confirmed benefits of herbal blends in the treated fowls, improving egg productivity, vitality and health.

The studies that used the term animal vitality basically made a connection between survival rates and animal growth. Production was the focus of interpretation for those data sets, with exception with the study of the marine ecosystem dynamic. Vitality and health are considered as different but interconnected terms.

Colony vitality – (3 studies)

Three papers used the term colony vitality as main core of their studies and, all of them were related to honeybee colonies. In common the papers explained in detail what vitality meant for the authors: life stimulation, biodiversity, ecosystem balance, production, interconnection man-nature.

Wintermantel and colleagues (2019) assessed how organic farming improved the vitality of honeybees' colonies, even in periods when the landscape has less abundance of flowers. Based on a study of six years, the authors provide data showing how industrial agriculture is directly linked to the reduction of pollinator diversity, hence decreasing the life of the agroecosystem itself. On the other hand, organic farming increased honeybee colony performance, colony survival and vitality, enhancing life manifestation. Wegener et al (2016) confirmed this negative effect of pesticides on the colony vitality, identifying the most dangerous pesticides to beehives. Judova et all (2016) assessed the impacts of

electromagnetic emissions, the reduction of flowering period due to expansion of monocultures and confirmed negative effects on the dynamic of the honeybee hive.

Ecosystem vitality – (10 studies)

This term was one of the most used in agricultural research to address vitality in agroecosystems. However, the definitions varied amongst the authors. Sheldon (2020) used the term to make a series of connections between ontologies, respect for the environment and how these ontologies influence the conceptions of human and environmental health. This author argues that ecosystem vitality comes from the traditional indigenous views, in which a vital force underpins all physical manifestations of health and harmony both for the land and for humans. He makes his case using as an example the traditional native knowledge from India which linked vitality with prana, the Sanskrit word for 'life force".

He later explains how ecological vitality is a concept that advocates for environmentalism awareness, bonding people, food, and their environment. At the same time, this perspective allows phenomenological critiques of the Cartesian model of embodiment. The author makes the case that what he calls naturalistic philosophy that allows for an applied integration of biology, ecology, and cosmology. The consequence of such ideas allows processes that enhance the ecosystem's natural way of healing itself, potentially bringing about moral change in the population.

By linking vital force with naturalistic concepts of human health to its food and environment, Sheldon (2020) claims that searching for vitality solidifies the vision of the human-nature context and, that such a view can influence political decisions. He again gives the example of the Indian government which has been supporting holistic and complementary forms of treatments for humans rather than an exclusively western approach to health, and that this attitude held a liberating potential to oppose colonial rule and concomitant forms of western-mind intervention in agriculture.

The work of Oksanen and Kontunen-Soppela (2021) argues that vitality of the ecosystem is expressed with the overall potential of plants to develop and produce food. They highlight that those plants use different strategies to overcome environmental stress, such as air pollution which can influence the vitality of the ecosystem. The authors described how air pollution (full of heavy metals and other substances) causes oxidative stress in plants, impacting growth, photosynthesis, crop production, nutritional value,

compromising the ecosystem functionality posing a threat to food production. In this sense the authors suggest that, to maintain ecosystem functionality or vitality, a diversity of plants species should be planted in urban spaces. Such variety would offer a rich source for air pollutant mitigation through their canopies in areas suffering from mixtures of air pollutants. Ecosystem vitality therefore is linked to biodiversity and ecosystem services.

Liu et al (2020) undertook an empirical field test evaluating ecosystem services of a rice-fish co-culture system as an alternative for the monoculture of rice paddy. They did so using an ecosystem service (ES) index based on the Millennium Ecosystem Assessment and Ecosystem Functions. For these authors, ecosystem vitality was expressed via a series of components: regulation of physical, chemical, and biological conditions; protection from farmland erosion; air purification; improvement of environment; development of tourism; physical and intellectual benefits and spiritual, symbolic, other interactions. All of these items are part of the ES index used. Liu et al (2020) argue that ES valuation is a useful technique that can foment interdisciplinary and holistic environmental decision-making by linking policy decisions to human benefits. It is suggested that each component of the ecosystem is interrelated and influenced by the other components – expressing an overall vitality.

A slightly different approach is taken by Caka (2020) when using ecosystem vitality. To this author, ecosystem vitality could be seen as synonyms to sustainable development goals in agriculture. The author expands his perspective:

> "*Sustainable food and agriculture have great potential in addressing hunger, poverty and sustainability issues through the provision of affordable and nutritious food, strengthening of livelihoods, promotion of inclusive growth, revitalization of rural and urban landscapes, and improvement of environmental performance structuring an ecosystem vitality" (2020, p 26)*

The authors concludes that a *holistic and systemic approach* towards strengthening the urban, peri-urban and rural is needed by integrating ecosystems preserving and restoring the natural capital and promoting ecosystem vitality.

Peng et al (2017) uses ecosystem vitality as an equivalent of ecosystem health. To express vitality or health, the authors used quantitative ecosystem indicators to support their equivalence. The authors explore data from the use of normalized difference

vegetation index (NDVI), landscape metrics, and ecosystem elasticity coefficient based on different land use types as quantitative indicators and later complementing these indicators with the coefficient of spatial neighbouring effect which characterizes the adjacency effect on ecosystem services that ultimately generates the index of integrated ecosystem health and vitality.

According to the authors: Promoting health means the integration of natural, social aspects involved in the land use. For the plants the vigour, metabolism or primary productivity are good parameters. Therefore, an integrated healthy ecosystem should focus on the ecosystem homeostasis, stimulating biodiversity.

If on the one hand, the authors offer a series of well explained ecological indicators to characterize their conception of health, on the other hand vitality is not described, but rather quoted as the overall umbrella term to connect all the nuances explored, including health.

Robert and colleagues (2012) argue that ecosystem vitality means agrobiodiversity and the conservation of the cultural and biological process, that agrobiodiversity practices are inseparable from the production and transmission of values and knowledge associated with cultivated plants. This interesting research developed by Brazil and France in the Amazon region, explores the agricultural method of the Mebêngôkre-Kayapó (traditional indigenous and non-indigenous people), using research methods combining anthropology, geography, agronomy and ethnobotany. Agrobiodiversity is analysed observing the organization through space and time, focusing in the number of the species and varieties cultivated.

Their results demonstrated that a vast number of plants (more than 400) continues to be cultivated despite the external influences promoted by big companies working in the region, confirming the vitality of the indigenous knowledge associated to agrobiodiversity enhancing the agricultural heritage. The authors highlight that this knowledge plays a significant role in forest conservation. A quote from one of the Mebêngôkre-Kayapó states:

> "*The diversity of cultivated plants means more beauty; it means the life force".*
>
> *(2012,p 20)*

In this paper the results show that the construction of agrobiodiversity is linked with extensive social networks; and that the vitality of the agroecosystems is the beauty

of the plots as manifested by the diversity of plants that it shelters because it reflects exchanges of knowledge, food, and objects.

Similarly, the impact of diversified agroecosystems is investigated by Doanah et all (2020). The authors examined the impact of the Association of Southeast Asian Nations (ASEAN) on ecosystem vitality (EV), from 2007 to 2016 in Indonesia, Malaysia, Philippines, Singapore, Thailand, and Vietnam.

The authors found a positive correlation between the quality of ecosystem vitality and the volume of agricultural exports. They claim that such positive association is found when applying the Ecosystem Vitality index. They explained ecosystem vitality as complex multi-faceted universe that reflects ecosystem health and each country's natural resource management. The EV is measured via six elements: I) water resources; indicate the proportion of wastewater treated in each country; II) agriculture; indicates the excessive nitrogen fertilizer use. III) forests; considers habitat preservation, climate change mitigation. IV) fisheries; reflects the sustainability of fishing activities. V) biodiversity and habitat; assesses the preservation of essential elements of biodiversity whilst maintaining associated ecosystem services. VI) climate change, and energy; reflect the ability of countries to reduce the number of carbon emissions per unit GDP and kWh electricity generation.

The main contribution of this paper is its attempt to embrace the complexity of factors that might reflect ecosystem vitality. Because of the diversified nature of ecosystem vitality (EV), environmental impacts on agricultural production and exports go beyond CO2 emissions to include biodiversity and habitats, irrigation and water sources, fertilizer discharges, and marine biological environments.

Here, vitality is associated with complexity and holistic analyses in the sense of multidisciplinary approaches to understand it.

Ecosystem vitality was also used in two studies related to water management. De Jonge et all (2019) reviewed the concepts of the marine environment in relation to subsets of food webs to assess the functionality of the marine ecosystem. Whereas Sonwane and colleagues (2020) focused on automatization of water systems and quality to rice irrigation systems. However, neither of the studies explores the concepts of ecosystem vitality, instead using the term to describe the overall welfare condition of the studied system.

Roy and colleagues (2020) also investigate the correlation of water and the ecosystem. However, these authors review the influence of ecosystem services and

diversified livelihoods and how human activity has been compromising this relationship, particularly in wetlands areas in India, where the negative impacts of the current agriculture model are seen. Different from the other water related studies, this one explains the authors' view on ecosystem vitality, referring to it in terms of *synergetic agroecosystem practices* that ultimately lead to homeostasis.

Again, it's possible to grasp an understanding of vitality as a force or condition related to harmony and equilibrium.

Finally, Mehla and Kumari (2012) explore the benefits of organic agriculture for health and sustainability. Throughout this review the authors present a series of data sets on how organic farming has helped in the livelihood of farmers. The benefits were perceived in their income, in the restoration of their soil fertility, the return of pollinators and the reduction of disease amongst the farmers.

Here it is possible to observe that the authors make a slight differentiation between health and vitality, the former being a consequence of the latter.

Rural vitality – (3 studies)

Three papers addressed vitality via using the term Rural Vitality. Carvalho and colleagues (2012) used the term rural vitality to address the human composition of the system - the quality of life of rural workers of the sugar cane crop. The authors conducted a field study with 340 workers for three crop seasons, evaluating the health index. This index is composed of functional capacity (FC), physical aspects (PA), pain (P), general health (GSH), vitality (VIT – liveness), Social Aspects (SA), emotional aspects, (EA) and mental health (MH).

They found that most of the time the health index was reduced, meaning "a reduction in the health index, diminishing workers vitality". Here the authors clearly mean that the quality of life of those rural workers was compromised.

Vidickiene and Gedminaite-Raudone (2019), used a similar approach. In this case the authors links rural vitality to quality of life. The authors explore the potentialities of the 'servitization initiative' that means to "rent a piece of garden in rural areas". This strategy focuses on engaging new rural people to old rural people in order to create new business models as well as promoting awareness of the importance of the agricultural sector in transition from a product-driven business model to service-driven business

model. This platform-based networking would also be used as a way to tackle the problem of ageing society and the decreased numbers of rural populations.

Community vitality – (2 studies)

Two papers approached vitality and extrapolated its definition towards community – community vitality. The authors used surveys and interviews to understand the impacts of agriculture and how it was perceived by their study communities. Goldberger (2011) focused on organic farmers and how they perceive their operations contributing to sustainable agriculture goals. According to the author, farmers said that their main contributions were related to environment, civil engagement (including community service, political activism, volunteering, and group membership) and economic benefits.

Robitaille et al (2022) studied the impacts of local food production on the wellbeing of communities. They were able to identify all the components involved on local food production and commercialization are determinants to enhance the ability of health eating whilst promoting access to healthier food with better prices, encouraging economic development by stimulating corporativism, thus promoting community health and vitality.

Peasants' vitality – (1 study)

One paper extended the meaning of vitality towards peasants. Junya et al (2021) traces historical connections, elucidating transformations on the agricultural world and how the autonomy of the peasants influences its vitality, where Vitality is taken to mean autonomy. The authors explains that during the historical transformation that society faced, changing from agrarian to industrial, some sociological studies painted peasants as vulnerable, in the face of big business entities. What the authors demonstrate with demographic and socioeconomic data is that the peasants, mainly small family-farmers, are:

"*Fragile but unbreakable; weak but never slackening (Junya et al., 2021,p 13)*"

Economy vitality – (3 studies)

Three papers linked vitality to an economic facet (Zhang et al., 2022; Russiana et al 2017; Wòjcik 2020). In common, all of them focus on the sustainable development agricultural economy. They have focused on combining social and economic benefits as the way to reframe public policies, rural credit, and subsidies. Strategies to develop shorter food supply chains that focus on the circular economy are suggested to enhance farmers' livelihoods.

Although important suggestions were made for sustainable economics, none of the papers approach vitality directly, but it was interesting to notice how the authors used the term to express the aliveness that new economic models can achieve.

Urban vitality – (3 studies)

This term was used by 3 studies to exemplify how the term vitality express aliveness or a process towards life. The authors define urban vitality as elements of the built environment that generate urban spaces that attract the presence of people, street buoyancy and the combination of diverse activities. Gómez-Varo et al (2021) vitality and its relationship with food retailers and food services (one of the most essential everyday activities). Using spatial analyses, the authors verified that food dynamics (through food stores, restaurants, bars, community gardens, takeaway services) play a significant role in integrating citizens as well as promoting consciousness regarding social aspects associated wellness.

Finally, Demling (2018) proposes urban vitality as the capacity of city buildings to be active spots for food production (living walls), climate change (green roofs) and recreational spaces (communal gardens) as urban citizens create a closer connection with the land, mainly in times of virtual reality.

This term complements community vitality, even though using different methods to do so. But, in common, both terms encompass the integration of the human and its close interconnection with its local environment exploring how the quality of life could be improved. In this case, urban vitality relates to food, human interaction and how this makes the urban spaces alive.

Territorial vitality – (2 studies)

Two papers used the term territorial vitality, both of them from France and focusing on sustainable livestock systems (Bedou et al 2017; Gourdine et al, 2021). Clustering their information, territorial vitality is associated with environmental conservation, development of sustainable food systems, valorization of cultural and territorial services, and strengthening of relationships between farmers and society. Also, items such as gastronomy heritage and cultural landscapes are key components of territorial vitality which ultimately contribute to create social bonds in the territories.

Different methods were used to comprehend this complex dynamic. Bedou and colleagues (2017) studied how cultural and territorial services influence agroecological transition in livestock. The authors interviewed key stakeholders and their questions were framed using Social Environmental Economic Goods and Services (SEEGS) indicators to analyze territorial vitality. For the authors, territorial vitality could be expressed via provisioning of services referring to food products, environmental services such as biodiversity maintenance, climate regulation, and water purification, cultural services such as recreational, esthetic, and heritage benefits and, rural community vitality and employment. Gourdine et al (2021) clustered indicators that would represent territorial vitality in provisioning services, ecological and socio-cultural aspects.

To conclude, territorial vitality is directly associated with the development of cultural services that could serve as prospects for the agroecological transition.

2.4.7. limitations of this systematic review

It's important to mention some limitations of this research. Firstly, I only looked for papers in English and in limited publication time frame (2002 – 2022). If in the one hand the time frame used yielded up-to-date literature, on the other hand older valuable papers could be left behind. The same applies for the language. It's true that most of the international papers are currently published in English, however many authors from non-English speaking countries certainly would have elaborated contributions in their own languages.

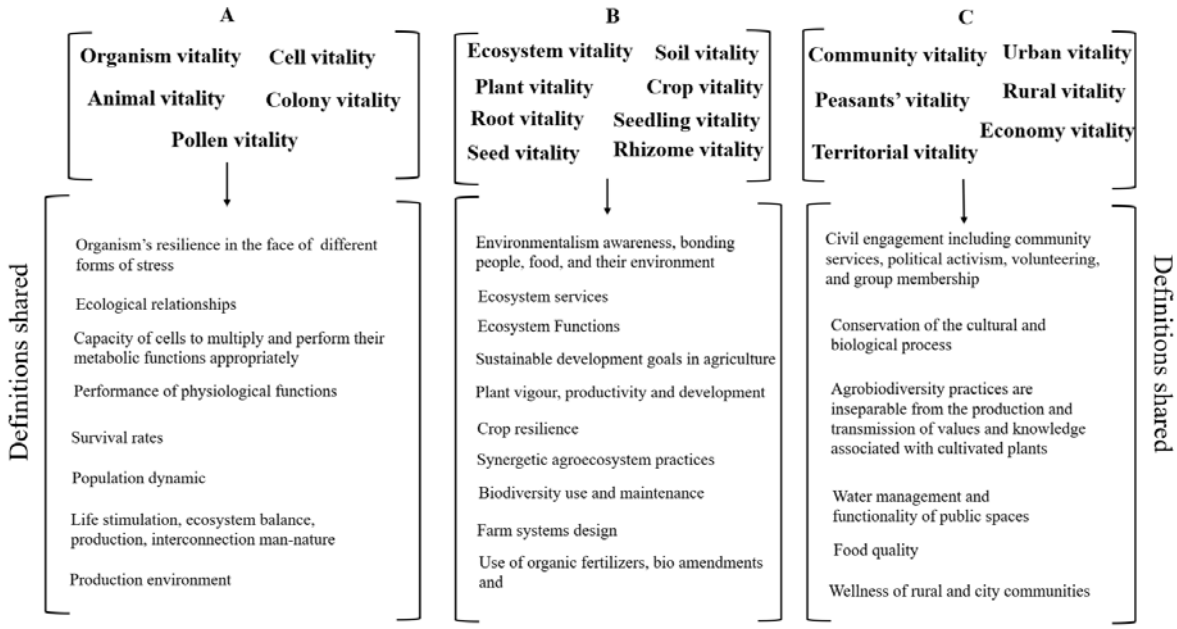
I also used only the search platform Scopus® for collecting the papers. I decided to so in order to minimize duplicated papers and to make the research agile. It's possible that different papers could be available using different searching platforms.

2.4.8. Definitions clustered accordingly to shared meaning and methods of analyses

The use of the term vitality in agricultural research evidenced a plurality of meanings for a multifaceted phenomenon. The discussions on vitality orbited around biological and social effects. In general, the results elucidated different sets of characteristics, that each express an optimum state of existence or manifestation, no matter whether for a biological system (seed, plant, animal or ecosystem) or a community. Therefore, after examining thoroughly the studies, it was possible to cluster their meaning and definitions in three main categories. Figure 11 displays these categories in the form of information clusters (A, B, C).

In the cluster "A", the terms focus on individual organism and the capacities that such organisms have to perform physiological functions in order to either produce food, a metabolic compound or survive. The cluster "B" concentrates most of the terms and studies identified in the review. These terms all express plant growth and development, more specifically defining vitality according to indexes and parameters such as ecological services for example. Cluster "C" gathers definitions that explore the manifestation of vitality through sociological perspectives including communities' dynamics and how this set of indicators are linked with the wellbeing of nature and mankind.

Figure 11 - Information clusters (A) individually, (B) ecosystem, (C) social community.



Source: elaborated by the author, 2022.

Overall, the fact prompt from the information clusters it's a connection inference of an optimum/harmonious positive set relationships, always directed towards life manifestation and maintenance, and such complex features could only be comprehended or fully expressed if described in terms of vitality.

2.4.9. Perceptions of the holistic feature neglected in agricultural research

The terms and definitions clustered in the figure above (figure 11), offered in the one hand, a set of objective parameters that collectively or individually could express vitality. On the other hand, none of the studies explored vitality in agriculture through its phenomenological perspective i.e the impacts of a community dynamic on the wellbeing including spiritual of its community. This fact is puzzling, as at its core vitality implies the awareness of being alive and, this question is one of the most important driving forces of philosophy of science questioning (NORMANDIN and WOLF,2013; GRECO, 2005). Maybe that perception is due to our trend to re-signify ecology only by "live" in the biological perspective.

From definitions on vitality in agricultural research (figure 11), in fact the notion of environmental awareness - which is rooted in the perception that society's health is dependent on the ecosystem health (ØSTERGÅRD, 2009) – implies a step further when exploring vitality as multifaceted phenomena. This exemplifies how important is to embrace complexity through diversity at all levels – using a holistic approach (DREYFUS, 1980) - is crucial to develop agricultural research that combines, reflects, and offer solutions over natural and social features (NUIJTEN et al., 2011; CHU, 2007). And this is a kind of thought that emerge from post-modernism or maybe still not reach modernism because the relationship crises among human being x Nature x Society have arrived at the point to ask ourselves what we have done so far…

Nevertheless, the environment awareness is also influenced by people's spiritual orientation (KAUFMAN and MOCK, 2014). Now, spirituality and religion although with similar connotations, are different in meaning. Religion deals with dogma whereas spirituality deals with consciousness awareness. According to Chen (2009), spiritual awareness, sometimes addressed as spiritual capital, is simultaneous recognition of love, guidance and intuition, creativity, higher personality traits and cultivated skills and knowledge. Thus, vitality could also bring our our way of thinking toward spirituality to the farming system construction dialogue with Nature as an all. Kaufman and Mock

(2014) when discussing on the connection between spirituality and farming systems, argues that what they called Eco-spirituality or Eco-consciousness - combination of ecological and spiritual features - arise when farmers distinguish their land not as mere mean of profit, but rather as a means to achieve a greater well-being having a direct impact on farmers health, economic and community benefits. For instance, Chen (2009) verified that organic farmers and organic food consumers are more environmentally conscious, and that consciousness leads to shift in their dietary and consumption habits. That explains the importance that spirituality plays in agricultural practices, thus should be more included in the Agronomy reflection. Wright (2021) give several examples when and how farmer take agricultural practices aligned with spirituality practices

Other authors like Lewis and Cassels (2014), explain that the spiritual aspect is grounded in the interpretation of spirituality around issues of ethics, morals, values, and worldview, combining spiritual values with farming practices, stimulating the elaboration of social, cultural and symbolic capital. Those set of capitals means the valuing of the local knowledge, skills, expertise, and experiences embedded in an individual perception, and interpersonal relationships based on mutual acquaintance and recognition, dialogue and trust (BOURDIEU, 1991). Steiner (1922) put vitality in the spiritual Science and make connections with cosmic forces.

Bourdieu (1991) consider that forms of capital will eventually turn into symbolic capital, enhancing the legitimacy of transformative actions, based on reputation and credibility of those actions. Such actions considering work in intimate partnership with nature and emphasized by an ecological and ethical approach to agriculture and food production. It is not just a method of growing, but a way of being, of living, and of making meaning, ultimately influencing farming practices and research towards autonomy and social justice. The spiritual dimension is such entity that facilitate all those connections and the result of that is Vitality of the system.

Therefore, the spiritual aspect should be considered within the perception of vitality in agricultural research, amidst its sociological and biological facets and implication. This perception in based on phenomenological and heuristic inquiry, where understanding the experience of a lived phenomenon helps to build structure in terms of education, providing possibilities for articulating theories of teaching and learning in close relation with concrete practice (BRINKMANN and FRIESEN, 2018; SULTAN, 2020). In this case sourcing methodologies for the reformation of agriculture towards sustainability.

2.5. CONCLUSION

The systematic review that vitality has been addressed in agriculture, sometimes through by metaphysical explanation but in most cases by a series of correlated terms that expressed vitality through biological and sociological manifestations.

The information clusters yielded from the systematic review allowed collect definition on attributes addressing vitality in in metrics such as crop production, plant growth and development, dynamic of crop system and other. Thus, the collective attributes could be seen as vitality expressors. Interestingly, vitality perception from a holistic perspective is missing though. Individually, each of these indicators cover one aspect of vitality in agriculture. Together, they could express the multifaceted aspects of vitality in agricultural research, and supporting the sustainable farming systems methodology, promoting health via its food production as its goal.

It is also possible to comprehend that vitality is expressed in community interactions, based on experience, knowledge and services create a certain kind of bond, one that dialogue with genuine interesting for the parts involved leading to sense of value for both parts are seeing as vitality parameters. Researching vitality in the agriculture help to revisit and progress the scientific reflection on the interactions between humans and its environment. It also systematized a series of terms and its definitions useful to be included in agricultural research as vitality expressors. In addition, the study addressed the development of sustainable agriculture via a systemic review perspective on vitality in agricultural research.

Also, in terms of methodology, the review influenced the selection of attributes to be assessed on the agronomic experiments (Chapter 3.) Specifically, vitality as defined and measured on the studies on plant vitality, crop vitality, seedling vitality, root vitality, rhizome vitality and organism vitality guided the selection of attributes to be evaluated as vitality expressors.

3. THE USE OF DYNAMIZED HIGH DILUTIONS (DHD) IN AGRICULTURE: A METHOD FOR THE SUSTAINABILITY OF STRAWBERRY CROPPING SYSTEMS

3.1. ABSTRACT

The strawberry (*Fragaria x ananassa)* is one of the most important crops for the Brazilian fruticulture, particularly for family farming due to its socioeconomic relevance. However, its management is done with high use of pesticides, having adverse effects, contaminating fruits and by-products with pesticide residues, creating environmental and human health hazards. The aim of this study was to evaluate the effect of the high-dynamized dilutions on the crop production and plant biometrics in strawberry plants. The experiments were carried out in 2019 and 2021, in a greenhouse with controlled environment, following a randomized block design with a double-blind treatment application. The high-dynamized dilutions of *Calcaria carbonica 12CH, Kali carbonicum 12CH, Phosphorus 12CH, Sulphur 12CH, Silicea terra 12CH*, significantly ($p < 0.05$) increased yield, canopy and root system development, fruit quality and, resistance to pest and disease. The results indicate that homeopathic preparations have the potential to stimulate plant vitality, enhancing crop development, increasing productivity and resistance to pest and disease when applied to strawberry plants.

KEYWORDS: Integrative homeopathy; Dynamized high dilutions; Plant Bio-stimulation; *Fragaria x ananassa; Vitality*

3.2. INTRODUCTION

3.2.1. Justification for choosing strawberry crop as the model plant for the experiment

At the Plant Sciences research program from UDESC, the research funds necessitate a focus on a commercially relevant crop in Brazil. Therefore, the strawberry crop (*Fragaria x ananassa*) was chosen as the plant-model to be used in the experiments testing HDDs. This was either due to the crop importance to the Brazilian fruticulture

industry and to its the relevance for strawberry family farmers livelihood. In addition, at UDESC, I'm part of two research groups, the Fruticulture and the Homeopathy and Plant Health. In this sense, testing high-dynamized dilutions in the strawberry crop converged interests of both research groups.

3.2.2. Strawberry culture, the cosmopolitan fruit

The strawberry has many characteristics that have placed the fruit in its cosmopolitan state. The fruit appeal to consumers, for its vivid colour, unique aroma and taste. It is an essential fruit for maintaining health since it contains a large amount of vitamin C and antioxidants, which contribute to preserving bones, teeth, gums, and blood vessels, among other things (GIAMPIERI et a., 2014). Due to these attributes, it has become a favorable business option for the fruticulture production chain in local and global markets (FAGHERAZZI et al., 2020). Strawberries have a significant social impact because they create employment for a large number of rural workers at diverse production scales (ANTUNES, 2013). The strawberry market is primarily a fresh fruit market, however, there is also a strong demand for the fruit in the industrialization process in the form of ice cream, jams, jellies, syrups, tea, and juices (ANTUNES et al., 2020).

3.2.3. Crop origins and history

Strawberries (*Fragaria x ananassa*) have been part of the human diet since prehistory. Archaeological records identified wild strawberries seeds, mainly *Fragaria vesca L.*, in Neolithic sites (DARROW, 1966). The species *F. chiloensis* was used more than a thousand years ago by the Mapuche people in central-south Chile, having been introduced to the region by zoophilic dispersion from North America. Another Chilean indigenous people, the Picunches, used strawberry fruits in various ways: fresh, dried, as a fermented juice, or as a medicinal infusion against indigestion, diarrhoea and haemorrhages (HANCOCK et al., 1999). The same author explains that *F. virginiana*, was used to flavour breads and drinks. Furthermore, there are indications that the fruit, besides being solely a target for foraging, was also cultivated in eastern North America.

In Europe, the Romans cultivated *F. vesca*, also known as alpine berry. The medicinal use of its leaves in Europe is widely registered throughout the 13th century

and, from the 14th century onwards, alpine strawberry cultivation becomes extensive and was the main commercialized species until the 19th century (TEMPERADO, 2016). During the 16th century, *F. virginiana* was widely introduced in France, England, Netherlands and Sweden and the Europeans cultivated both white-fruited and red-fruited plants in both ornamental and vegetable gardens.

The modern strawberry (*Fragaria x ananassa*) originated in Europe, specifically in France around 1750 by a hybridization between the American species *F. chiloensis Mill.* and *F. virginiana Duch*. From Paris, the new hybrid was distributed to botanical gardens and gardens in the Netherlands, England, Belgium and Germany. A curious fact is that the seedlings brought from Chile were vigorous but did not produce fruit, because they were dioecious. However, due to farmers' observational skills, they learned that they could produce fruit if they intercropped Chilean with European ones (HANCOCK et al., 1999). The plants from these cross produced vigorous plants with fruits of exceptional size, with red pulp, and with adaptive potential to different climates (SIMPSON, 2018).

Strawberry was introduced in Brazil, but unofficial information indicates that it happened around 1950, in the State of Minas Gerais, more precisely in the Municipality of Estiva (TEMPERADO, 2016). However, only after the 1980s was the crop expanded its cultivated area in the country, especially due to the adaptation of new cultivars to tropical weather.

3.2.4. An overview of the strawberry production around the world

Strawberry farmers vary in profile regarding their farms size and farming methods from country to country. Overall, properties dedicated to strawberry cultivation have an average cultivated area of 0.5 ha to 2.5 hectares, however, larger areas of cultivation, belonging to large companies, also exist, exceeding 15 continuous hectares or more (ANTUNES et al., 2020).

The strawberry production (table 4) has been exponentially increasing since the early nineteenth century after cultivars of the cultivated strawberry (*Fragaria x ananassa*) were developed. According to FAO (2020), fruit production grew from 7,879,108 tons in 2013 to 12,106,585 tons in 2020, an expansion of 46%.

Table 4 - World Strawberry production and cultivated area.

Source: FAOSTAT (2020); Antunes et al (2020).

The top six world's producers are: China, USA, Mexico, Turkey, Egypt and Spain. The planted area has increased around 41% in the last eight years, since in 2013 it was 369,569 hectares and in 2020 it was 522,527 hectares. Currently, strawberries are produced commercially in 76 countries, evidencing its popularity because they are considered to be a healthy food that is affordable, pleasant to eat and requiring minimal preparation (GIAMPIERI et al., 2017). Annual fruit consumption varies from region to region, ranging from 1.5 kg/person/year to 5 kg/person/year. The average production ranges from 15 ton/hectare to 51ton/hectare (SIMPSON, 2018).

This significant industry is supported by a global trading. The total exported value of strawberries in 2020 was 2.6 billion USD (891.3K tons). The main exporters are Spain - 694.0 million USD, 26.5%; USA - 475.2 million USD, 18.1%; Mexico - 432.4 million (TRIDGE, 2021). In terms of imports, the total imported value in 2020 was 2.9 billion USD, and the major importers were: USA - 609.6 million USD, 21.1%; Canada - 340.5 million USD, 11.8%; Germany - 285.5 million USD, 9.9%; (FAOSTAT, 2020).

Due to the broad adaptability of strawberry plants, many countries have developed local breeding programmes, creating cultivars that are specifically adapted for the local climatic conditions and market demands (MEZZETTI et al., 2018). This has expanded the seasonal cultivation window. Today, strawberry plant cultivars could be low chill cultivars that will crop over a long period in late winter and early spring, or plants adapted

to colder winters a higher chilling requirement cropping until early winter (Barth et al., 2019).

In Europe, Spain is the most important producer, supplying around 30% of EU demand, exporting approximately 83% of its production, mainly as fresh berries, particularly from February to May when the main market is in northern Europe, especially Germany, France and the UK (SIMPSON, 2018). Imports to and exports from outside EU are relatively small compared to the internal trade, where mainly Morocco and Egypt supply about 4% of EU volumes during the winter, before the Spanish season begins. In addition to exports within the EU, 6% of production goes to countries outside of the EU, mostly non-members of the EU (SIMPSON, 2018).

In the UK, the cultivation has developed significantly, going from 40,100 tons of strawberries in 1996 to over 115,500 tons in 2019, an increase of 188% (DEFRA, 2019). This production is concentrated in Cornwall, Devon, Dorset, Isle of Wight, Sussex and Kent (responsible for almost 70% of the production). The fruit production peaks from March to June, with the county importing winter strawberries from November to May (PELHAM et al., 2020). Within the UK territory, farmers cultivate three cultivars: June-bearing is the most common in the UK, this variety fruits for three weeks; everbearing strawberries will fruit up to three times per year; day-neutral strawberries will be abundant from July to September (CALLEJA et al., 2012).

Moving to another important productive area, the Eurasia, Turkey is one of the world's biggest producers. In the last decade, a growing curve of 140% was experienced by the country (SIMPSON, 2018).

In Asia, China, South Korea and Japan are the main producers. China stands out as the world's main producer with the Chinese production increasing 61% in the last decade, accounting for a production more than the combined output from North America and Europe (SIMPSON, 2018). Most strawberry production is concentrated in winter and spring, using low-chill short-day cultivars. However, due to a high demand outside this period has recently led to an increase in summer and autumn production using day-neutral cultivars (ZHANG et al., 2016).

In the north and central Americas markets, USA and Mexico are the biggest producers. The USA is the second world's biggest producer after China, and its production is concentrated in California (88%) and Florida (9%) (GUTHMAN and JIMÈNEZ-SOTO, 2021). The United States produces almost 20% of the world crop and leads the world in production per unit area, with the strawberry industry value between

$1.3 billion and $1.8 billion during the past 3 years (USDA, 2017). In Mexico, the main strawberry growing regions are Michoacan and Guanajuato in central Mexico and Baja (WU et al. 2012). Mexico exports 30–45% of its crop, making it the world's third largest exporter of fresh strawberries (SIMPSON, 2018).

South America produced around 312,766 tonnes of strawberries on approximately 11,479 hectares (FAOSTAT, 2020). The main strawberry producing countries in South America are Brazil, Chile, Peru and Argentina.

Brazil is the largest producer in South America, accounting for 33% of all production in South America, with a cultivation area of 4500 ha yielding approximately 165.440 tons (DE CARVALHO et al., 2021). Brazilian strawberry production is concentrated in the states of Minas Gerais, São Paulo, Rio Grande do Sul, Espírito Santo, Santa Catarina, Paraná and the Federal District (FAGHERAZZI et al., 2017). More than 90% of the production is sold in the domestic market as fresh fruits (ANTUNES e PERES, 2013). The Brazilian strawberry export is fairly small (<9%), being the main markets France (40%), Spain (12%), and Germany (6%), (BRASIL, 2022). Specialized nursery industries in Argentina, Chile and Uruguay source seedlings to nearly all countries in South America, however, Brazil have been developing and intensive breeding program in recent years (ANTUNES e PERES, 2013). Regarding the Brazilian nursery industry, most strawberry plants are produced by growers themselves – around 250-300 million plants – however, most of the demand cannot be meet by growers in the main producing regions in terms of quality and quantity (GONÇALVES and ANTUNES, 2016). In response to this, specifically the southern states of the country import plant from Patagonian nurseries (Chile and Argentina). Approximately 60% of the seedling-plants used in Brazil are imported (ANTUNES and PERES, 2013).

In Brazil, day-neutral cultivars and new production methods made possible for strawberries to be grown and commercialized all year long, yet, the fruit still has higher prices from November to early winter and a lower supply of fruit on the market from June to November (FAGHERAZZI et al., 2017).

3.2.5. Fruit nutritional composition

The strawberry (*Fragaria* × *ananassa*) is rich in bioflavonoids, vitamin C, vitamin A, vitamin B2 (riboflavin), ellagic acid, pectin, cyanidine, pelargonidine, quercetin, catechin and cinnamic acid derivatives (p-coumaroyl), also possessing a remarkable

nutritional composition in terms of micronutrients, as well macronutrients such as potassium, calcium and phosphorus; folates, and non-nutrient elements, such as phenolic compounds, that are essential for human health (CRESPO et al., 2010; TULIPANI et al., 2011; GIAMPIERI et al., 2014) Strawberry phenolics are known mainly for their anti-inflammatory and antioxidant actions. Studies having been demonstrating that the fruit nutraceutical characteristic positively influenced pathways involved in cellular metabolism and cellular survival (GIAMPIERI et al., 2014).

Because it is rich in antioxidants, it can reduce cardiovascular risk factors such as high blood pressure, hyperglycemia, dyslipidemia and inflammation (GIAMPIERI et al., 2017). Other studies demonstrate the antiproliferative activity of strawberry extracts in cancer strains, such as T29 (colon cancer) and MCF-7 (breast cancer) and highlight that organically produced strawberries showed this activity strongly – because they synthesize more secondary compounds with anticarcinogenic activity than conventionally produced strawberries (OLSSON et aI., 2006; AMATORi et al., 2016).

However, there is a major issue compromising the benefits of the fruit to human health: the use of pesticides.

3.2.6. The pesticide problem: a heritage from the industrial approach to agriculture

Despite the potential benefits for human health that consuming strawberries may bring, the fruit managed under industrial practices, focusing on the use of pesticides and soluble fertilizers, has placed the fruit worldwide among the most contaminated by pesticides residues (TADEU et al., 2010). To have an idea of the enormous volume sprayed on the crop per year, in the US over 12 thousand hectares of strawberry production were sprayed with over 500 thousand kg of pesticides in 2012, making the fruit the fourth-highest pesticide user among all California crops (CADPR, 2014). Moreover, Song et al (2020) showed that in China, strawberries had twice as many chemical pesticide residues per unit area as the world average. Further, data collected in China from a survey done with strawberry farmers from that country, regarding the use of pesticides identified that farmers rarely applied it in accordance with the recommended dose (Zhang et al., 2018).

In Brazil, the program for the analysis of pesticides residues in food (PARA), analysed strawberry fruits from the season 2018 to 2020 and evidenced that 60% of the

fruit-samples over the maximum residue limit (MRL) permitted, containing around of 35 different pesticides active ingredients, mainly procymidone, carbendazim, organophosphate and difenoconazole (ANVISA, 2016; FRAGA, 2020). Over the last decades, research have verified that pesticide residues – including the ones found in strawberries, cited above - have negatively affect human and environment health (RANI et al., 2021). Scientific evidence links ingested pesticides to short- and long-term health problems, including neurological deterioration, reproductive health problems, learning, and developmental disabilities, cancer, endocrine disruption, and metabolic disorders (MOBED and SCHENKER, 1992; ARCURY and QUANDT, 2003; LI et al., 2011; SONG et al., 2020).

When examining the management that strawberries cultivated in the conventional system receive, Tadeu et al (2010) and Antunes (2019) assessed that the system can apply an average of 45 pesticide sprays a year/season. The deleterious contamination by pesticides residues is not exclusively a problem of the fresh fruit. Miszczak et al (2015) evidenced the dietary risk to consumers from strawberry by-products such as jams is comparable to that from fresh fruits as the authors identified pesticides residues in 60% of the samples in conventional origin strawberry by products in Czech Republic.

In addition, the problems of pesticide usage in the strawberry culture are enhanced when the pesticides are used under greenhouse conditions. Song et al (2020) demonstrated that pesticides sprayed in greenhouses increased the residue levels and potential safety risk due to air contamination and residues deposition on the greenhouse internal structure and plants. Such toxic exposure intersects with other structural vulnerabilities commonly observed in industrial farming, which directly impacts the ecosystem’s equilibrium (CARTWRIGHT, 2013).

This kind of crop management is partially influenced due to the remediation approach, where the technical advice (which in the author’s professional experience in Brazil is mainly done by professionals linked to agrochemical companies’ retailers), promotes the use of synthetic pesticides in nearly every phase of the strawberry production cycle.

Unlike most other important chemicals, pesticides are designed to impact living systems. Pesticides contain more than just active ingredients, known as 'inert' chemicals, such as solvents, surfactants, and preservatives, they may have a toxic impact independent of their active ingredients (BLAIR et al., 2015). Pesticides impact biodiversity and accumulates its effect through the trophic levels, thereby increasing the risk of poisoning

over the food chain and water supplies (MAHMOOD et al, 2016). Furthermore, farm workers are constantly exposed to these products in the field, causing health problems through their handling and inhaling as well as economic problems that come with dependency of their usage (SAXTON et al., 2015). This contributes to the negative social impact of industrial agriculture (QUESADA, et al., 2011).

The deleterious results observed in the field and through research have caught public attention and awareness regarding this fundamental problem of producing food based on an approach that compromises the environment, poisoning both food and people (RANI et al., 2021).

There is an urgent need for alternative management tools to mitigate the problems caused by pesticides to the health of environment and society.

3.2.7. Moving towards more sustainable strawberry production: homeopathy and high-dynamized dilutions as an alternative to the use of pesticides

The use of homeopathic preparations and its potential contribution to sustainable agriculture has been intensively researched (ÜCKER et al., 2018). The main reasons for that include its usage safety – HDDs are biodegradable, non-pollutant and non-toxic – when compared to pesticides (SAVIAN et al., 2018), and the salutogenic nature of the homeopathic treatment, where its main action is not target on the pest or disease, but rather stimulating the plants natural capacity to synthetize defence compounds (DEBONI et al., 2021), increase growth and vigour (DOMINGUES et al., 2019) and resilience (LÖSCH et al., 2021).

Several authors have reported benefits on improving plant performance in different agronomical aspects by substituting pesticides by homeopathic preparations. For instance, on crop production, Verdi and colleagues (2018) increased rice yield and, Modolon et al (2012) improved tomatoes production using *Sulphur 12CH*. Regarding the management of pests and disease, Lösch et al (2021) promoted resistance to pest and disease in sweet pepper (Capsicum annuum L.) using *Calcaria carbonica* 30CH and *Sulphur* 30CH.

Another potential use of the homeopathic preparations is as plant growth promoters. Domingues et al (2019) used *Arnica montana* 30CH and *Calendula officinalis* 30CH to promote regrowth in Yerba-mate (*Ilex paraguaiensis)*. Similarly, Faedo et al., (2019) verified higher germination among lettuce seeds treated with

Arsenicum album 7CH and Pullido et al (2017) incremented growth on broccoli using *Silicea terra* 6CH, *Carbo vegetabilis* and *Sulphur* at 30CH.

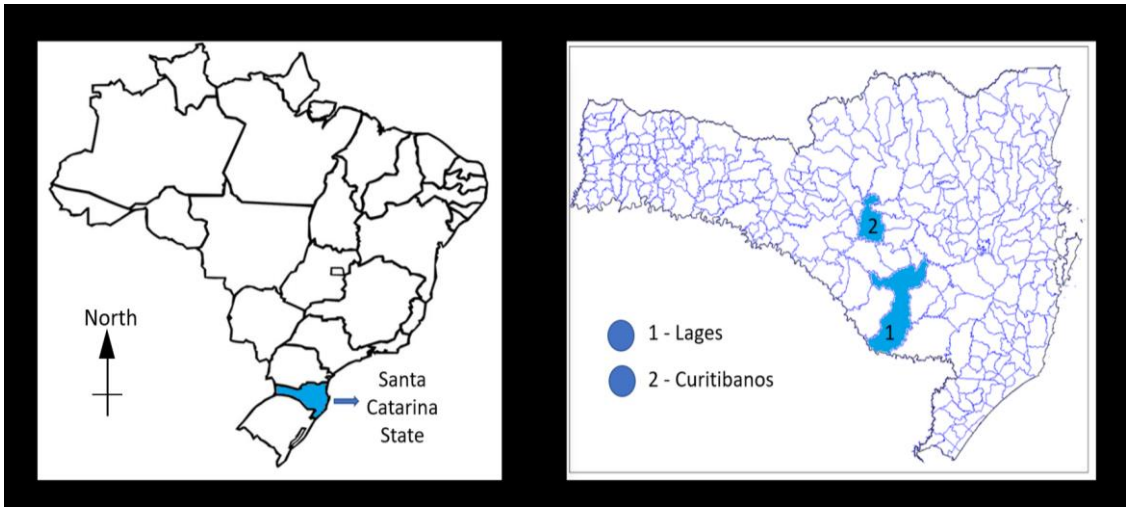
However, studies testing high-dynamized dilutions on strawberry crop are still scarcely when compared to other crops. Therefore, the objective of this study was to evaluate the effect of high-dynamized dilutions on the development and productivity of strawberry (*Fragaria x ananassa*).

3.3. METHODOLOGY

3.3.1. Experiment localization

The experiments testing the homeopathic preparations on strawberry plants were carried out at the Agroveterinarian Science Centre (CAV) of the Santa Catarina State University (UDESC), Lages-Brazil, from June to November, in 2019 and repeated at the Santa Catarina Federal University, Curitibanos-Brazil from June to November in 2021 (Figure 14).

Figure 12 - Geographical localization of the controlled trials in Santa Catarina state/Brazil.

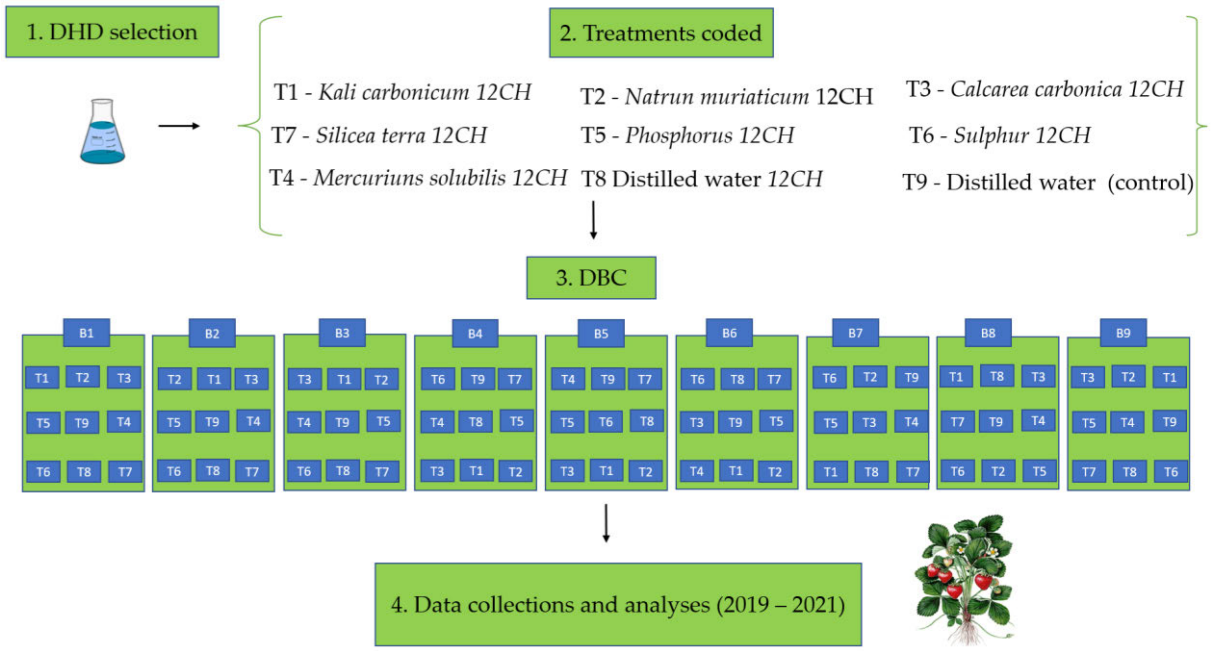


Source: developed by the author (2022)

3.3.2. Experimental design

The experiment followed a randomized block design with a double-blinded treatment application, with nine treatments and nine repetitions (figure 13).

Figure 13 – Experiment design



Source: developed by the author (2022).

Each experimental plot (figure 13) consisted of one strawberry plant allocated in a 3.6L plastic vase filled with plant substrate.

The plant substrate was composed by 25% of cow manure, 50 % of local soil – (Humic Cambisoil; EMBRAPA 2006), 10 % of Ipê® commercial ecological plant charcoal, 5% of Malleti® commercial organic rice bran, 1% of Guimaraes® commercial organic brown sugar, 5% of expanded vermiculite (medium grain size) and 4% of organic commercial Tecnomax® plant compost. The solid composition was moisturized with 20L of tap water.

This substrate composition and ingredients are suggested by Restrepo et al (2013) and are commonly used by agroecological strawberry farmers in the region. The substrate nutritional composition (given below) was analysed by the laboratory of Soil Analysis (LAS) from the Department of Soil and Natural Resources (DSRN) from UDESC. The

substrate composition met the nutritional recommendations for the culture (ANTUNES et al., 2020).

Figure 14 - experimental plot

Source: developed by the author (2022).

Figure 15 -Experiment substrate composition

pH in Water	SMP index	Effective CTC	CTC in pH 7*	Bases Saturation (%)	Aluminium Saturation (%)	Clay (%)	O.M (%)	O.C (%)
5.6	6.2	15	18.50	81.09	0.00	38	6.5	3.48

*(cmolc/dm3)

Ca	Mg	Al	P*	S	Na	K	Cu*	Zn*	B	Fe*	Mn
8.09	4.15	0.00	180.5	1	1	1.20	2.1	1.9	0.51	98.3	10.5

*Mehlich; cmolc/dm3; Laboratory of Soil Analysis (LAS) from the Department of Soil and Natural Resources (DSRN) from UDESC

The strawberry variety *Pircinque* was used in the experiment owing its good adaptation to Brazil's southern region as well as to its popularity amongst organic strawberry farmers. *Pircinque* seedlings were obtained from a certified nursery in the city

of Farroupilha-RS. These were classified according to the crown diameter into three categories: low vigour (1mm - 3mm), medium vigour (3mm-6mm), high vigour (6mm - 9mm). All seedlings were transplanted on the same day. The bare rooted seedlings were ensured uniformity by root pruning through a cross section, leaving them 8 cm in length.

The plants were irrigated daily with an automatic irrigation system type nipple, with a volume of 350 ml of water/plant. The temperature of the greenhouse was controlled and kept up to 27 Cº with the help of an enforced ventilation system.

3.3.3. Statistical analyses

To verify the effect of the DHDs on crop production, plant development, root system, fruit quality and plant pest and disease of the strawberry plants, the statistical analyses were performed using the free environment R® software (R Core Team, 2021), using the classical variance analysis model easyanova package, DBC and Dunnet test with 5% of significance level.

The assumptions of normality and homogeneity of variance were verified by Bartlet and Shapiro Wilk tests, respectively. In cases where at least one of them was not met, the transformation proposed by Box-Cox (VENABLES and RIPLEY, 2002).

3.3.4. DHDs preparation and selection

To follow the double-blind treatment application, the dynamized high dilutions (DHD) were made and coded by the Laboratory of Homeopathy and Plant Health at the Santa Catarina State Research and Extension Agency (EPAGRI) (Figure 16) according to the recommendations of the Brazilian Homeopathic Pharmacopoeia (Brazil, 2011). The laboratory codded the treatments and afterwards, they were applied fortnightly, dosing 1ml of the homeopathic preparation added to 50 ml of distilled water and this solution was applied to the strawberry plants base using a graduated irrigation container.

Figure 16 - Homeopathic preparations made and coded at the Laboratory of Health Plant and Homeopathy at the Santa Catarina State Research and Extension Agency .

Source: author (2022).

The dynamized high dilutions tested in this study were *Calcarea carbonica* 12CH, *Kali carbonicum* 12CH, *Mercurius solubilis* 12CH, *Natrun muriaticun* 12CH, *Phosphorus* 12CH, *Sulphur* 12CH, *Silicea terra* 12CH, distilled water 12CH (negative control) and distilled water (control). All the treatments were potentized to the 12CH, testing previous studies that used this potency for the selected DHDs on plant disease control and plant vigour promotion (ÜCKER et al., 2020). Overall, the study also considered the previous research with DHD in plants from Kaviraj (2018) and Stangarlin and Bonato (2015). The number of treatments (9) were selected in order to favor statistical inferences (9X9), where the number of treatments is equal to the number of repetitions, minimizing the number of plants required to detect statistically significant differences between treatments tested (VENABLES and RIPLEY, 2002).

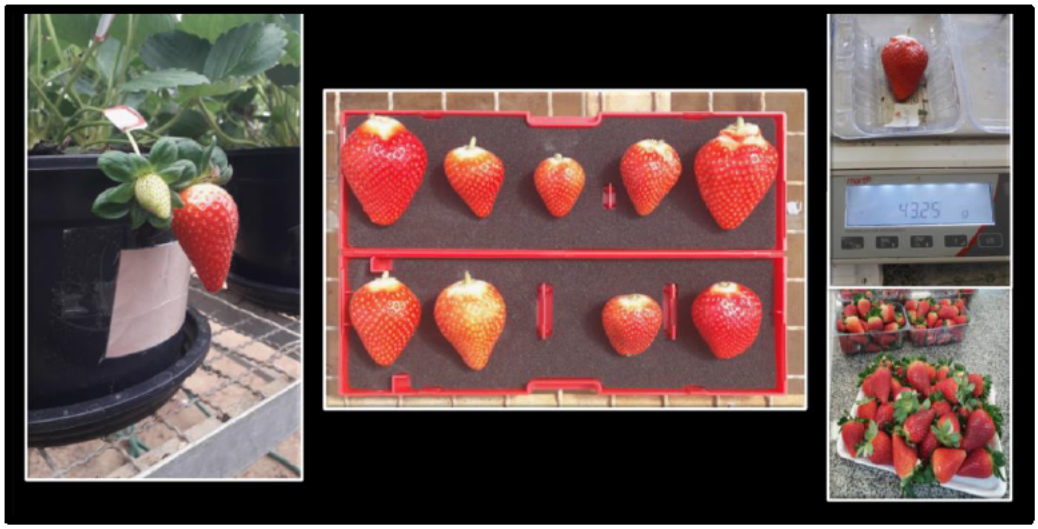
3.3.5. Parameters to assess strawberry vitality and the biostimulator effect of DHDs

The parameters assessed in this experiment originates from the systematic review on vitality in agriculture (chap. 2) and the literature review done for the introduction (chap. 1). They are linked to agronomical vitality expressors, in particular, crop production and plant development, fruit quality and phytosanitary indicators, root system and plant architecture were assessed.

3.3.6. Crop production and development

The crop production (figure 17) was assessed by fruit harvest. The fruits were harvested weekly (3x week) when they were ripe (75% of the fruits skin were red) weighed using precision digital electronic scale (0.0001g), model GE1302, brand Sartorius® and classified accordingly to market classification where fresh market fruits (> 12g/fruit) and industry fruits (<12g/fruit).

Figure 17 – Strawberry samples and crop production from the agronomical experiment testing DHDs, 2019-2021.



Source: author (2022).

The crop development and architecture (figure 18 and 19) were assessed every 15 days. The plant height was measured with millimetric ruler from the crown base to the canopy, from the transplant day until the end of the experiment. The number of green and dead leaves were counted from the moment of transplant to the end of the experiment. The stolons were marked, and its production counted per plot across the season. The flowers were marked, and the number of viable and death flowers were assessed. The chlorophyll content was obtained from marked leaf's using the equipment SPAD® 502 PLUS, Konica Minolta ® (Ozaka, Japan).

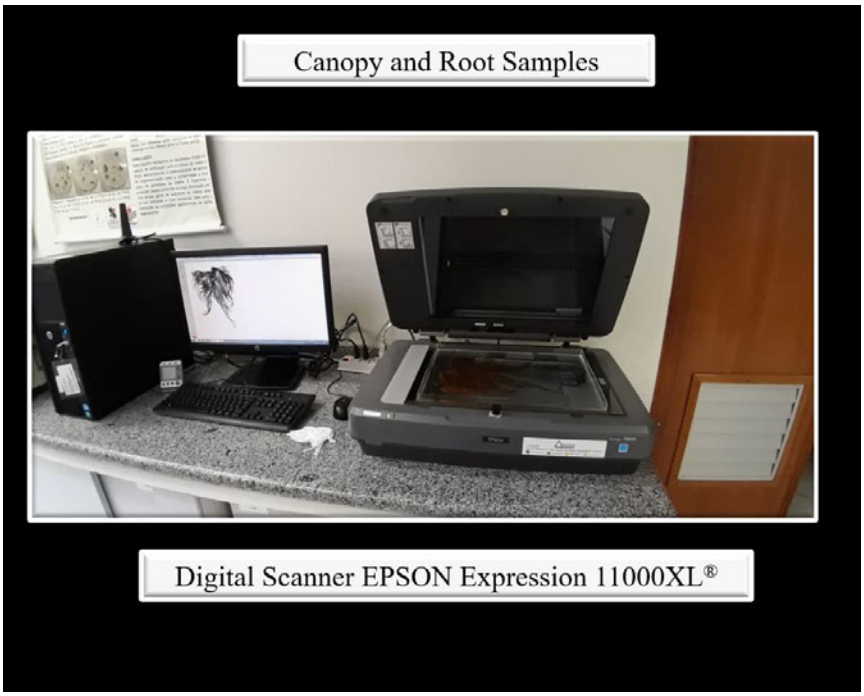
Figure 18 - Crop development and plant architecture

Source: author (2022).

At the end of the cultivation period, the canopy area and root area were analysed using the digital Scanner EPSON Expression 11000XL®, using the software WinRHIZO® and WinLeaf® (LC4800-II). The crown diameter was measured using a digital caliper Starret® 799. The leaves and roots were weight for dry and fresh mass. The roots and leaves were dried in an air forced chamber (60 Cº) for 72 hours before weighted for dry measurements.

To prepare the root samples, a laborious and careful work that consisted on gentle washing and drying of the strawberry roots samples in the preparation for the scanner measurements. The scanner (Scanner EPSON Expression 11000XL®) is calibrated for image Analysis with REGENT INSTRUMENTS® and root system sofware WinRhizo.

Figure 19 - Plant development and plant architecture



Source: author (2022).

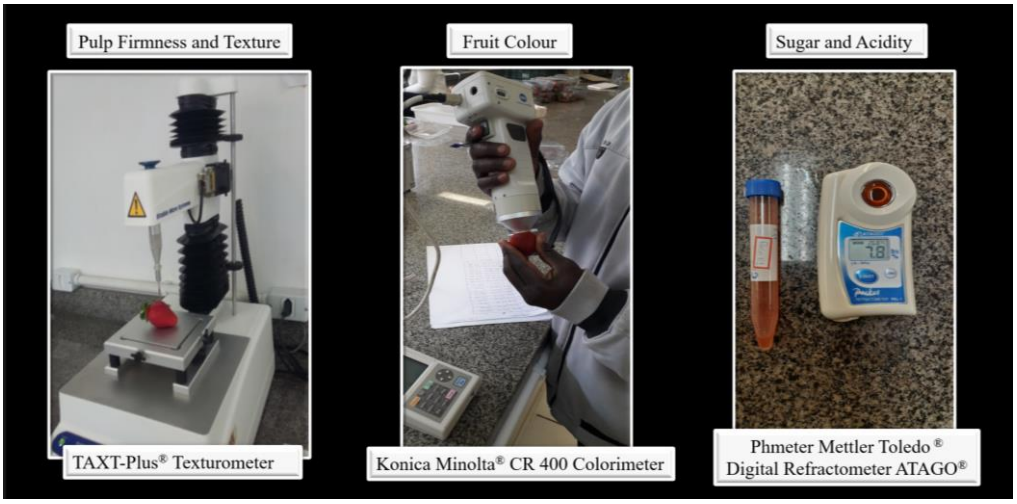
3.3.7. Fruit quality

The fruit quality (figure 20) considered the colour of fruit epidermis [luminosity (L), chroma (C) and hue angle (hº)] was evaluated with a Konica Minolta® CR 400 colorimeter (Osaka, Japan) in the equatorial region on opposite sides of each fruit. Where, L expresses luminosity on a scale ranging from 0, corresponding to black, to 100 corresponding to white. C expresses colour saturation. H ° defines the basic colour, where 0 ° = red, 90 ° = yellow and 180 ° = green.

The texture attributes (forces for pulp penetration and peel rupture) were determined in the equatorial region of the fruits, using a TAXT-Plus® texturometer (Stable Micro Systems Ltd., United Kingdom), in Newton (N). Pulp penetration was performed on two opposite sides of the fruit, using a 2 mm diameter PS2 tip without removing the epidermis. The tip was introduced at a depth of 8 mm, with pre-test, test and post-test speeds of 10-, 1- and 10-mm s-1, respectively.

The SS (ºBrix) content was determined with the aid of digital refractometer ATAGO®, using the extracted juice from the fruit samples.

Figure 20 - Fruit quality parameters

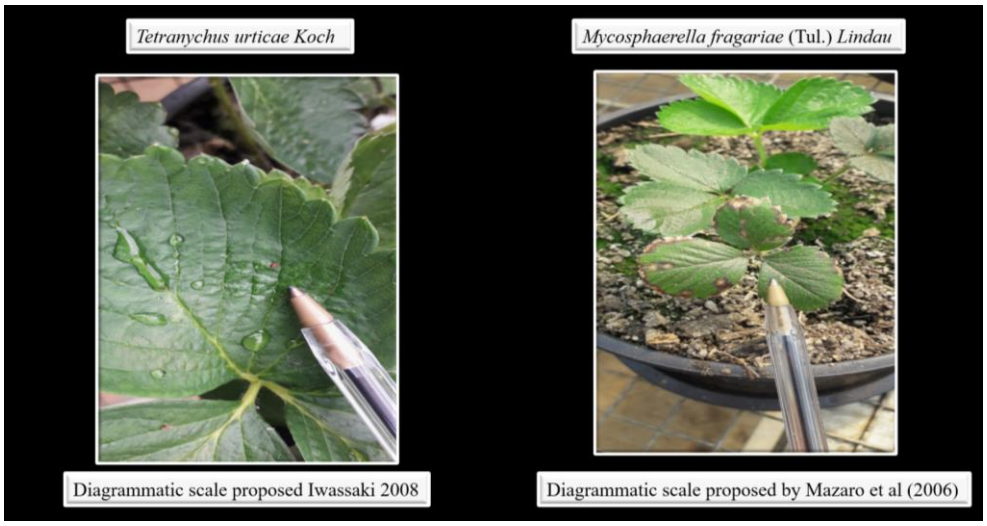


Source: author (2022).

3.3.8. Phytosanitary assessment

The phytosanitary assessment on this research focused on the most important associated organisms to the strawberry culture (BRUGNARA et al., 2014; PIROVANI et al., 2015), the leaf spot (*Mycospaerella fragariae (Tul) Lindau)* and spider mite (*Tetranycus urticae Koch*).

Figure 21 - Phytosanitary assessment



Source: author (2022).

The phytosanitary status of the system was verified every 15 days. The leaf spot intensity and frequency in strawberry leaves were assessed with the aid of the diagrammatic scale proposed by Mazaro et al (2006), evaluating the number of leaf lesions per plot. For the mites, the diagrammatic scale was used (Iwassaki 2008), counting the number of insects present in each of the experimental plots.

3.4. RESULTS AND DISCUSSION

3.4.1. Crop production

The results of crop production are presented in the tables 5 and 6. Three treatments significantly increased the yield of fresh market fruits (>12g/fruit) in both experiments when compared to the control: *Kali 12CH, Sulp 12CH* and *Phos 12CH*.

Table 5 - Crop production of strawberry plants treated with high dynamized dilutions (DHD) in Lages-SC/BR, 2019.

DHD	Yield (g/plot)	Total production (g)	Fruit (nº/plot)	Total fruit Production (nº)
		Fresh market fruits		
Kali 12CH	98.87 a	889.86 a	6.77 a	61.00 a
Sulp 12CH	95.00 a	854.87 a	6.77 a	61.00 a
Phos 12CH	90.86 a	817.73 a	6.55 a	59.00 a
Merc 12CH	70.56 b	632.05 b	4.66 a	42.00 b
Natu 12CH	68.03 b	612.32 b	4.44 b	40.00 b
Calc 12CH	65.50 b	589.50 b	4.44 b	40.00 b
Sili 12CH	60.23 b	542.07 b	4.55 b	41.00 b
HD 12CH	58.61 b	527.65 b	4.33 b	39.00 b
Control	57.45 b	517.10 b	3.44 b	31.00 b
		Industry fruits		
Kali 12CH	33.71 ^{ns}	303.40 b	6.11 ^{ns}	55.00 ^{ns}
Sulp 12CH	35.82	322.40 a	6.00	54.00
Phos 12CH	32.27	290.49 b	6.11	55.00
Merc 12CH	30.46	274.20 b	5.77	49.00
Natu 12CH	23.01	207.16 b	6.00	51.00
Calc 12CH	26.00	234.06 b	5.77	50.00
Sili 12CH	24.64	221.80 b	6.00	52.00
HD 12CH	23.89	215.05 b	5.00	45.00
Control	56.10	291.80 b	5.11	46.00

Means followed by the same letter in the columns do not differ according to Dunnett's test ($p < 0.05$); ns = not significant; Significant at the 5% probability level ($p < 0.05$); DHDs: Kali = *Kali Carbonicum, Sulp = Sulphur, Merc = Mercuriuns solubilis, Phos = Phosphorus, Natu = Natrum muriaticum; Calc = Calcarea carbonica, Sili = Silicea terra, HD= Distilled water dynamized, Control= water*; 12CH= centesimal Hahnemannian; Fresh market fruits and Industry fruits are a market classification where commercial (> 12g/fruit) and industry (<12g/fruit).

In 2019, plants treated with these DHDs yielded a mean of 800g of strawberries, with an average of 6 fresh market fruits/plot (> 12g/fruit), totalizing around of 60 fruits for treatment.

The data from 2021 confirmed the positive influence of *Kali 12CH, Sulp 12CH* and *Phos 12CH,* yielding again a mean of 830g of strawberry, with an average of 6 commercial fruits/plot (> 12g/fruit), accumulating around 60 fruits for each treatment.

There were no significant results regarding the industry fruit production (<12g/fruit) in 2019. However, in 2021 *Kali 12CH, Sulp 12CH* and *Phos 12CH* yielded over 170g of strawberries, harvesting around 20g/plot with an average of 6 industry fruits/plot (<12g/fruit), totalizing about 54 fruits for each treatment.

Table 6 - Crop production of strawberry plants treated with dynamized high dilutions (DHD) in Lages-SC/BR, 2021.

DHD	Yield (g/plot)	Total production (g)	Fruit (nº/plot)	Total Fruit Production (nº)
		Fresh market fruits		
Kali 12CH	85.70 a	771.30 a	7.33 a	66.00 a
Sulp 12CH	115.82 a	1042.34 a	8.33 a	75.00 a
Phos 12CH	77.17 a	694.53 a	4.67 a	42.00 a
Merc 12CH	58.21 b	523.85 b	3.67 b	33.00 b
Natu 12CH	42.78 b	385.02 b	2.44 b	22.00 b
Calc 12CH	55.99 b	503.88 b	3.56 b	32.00 b
Sili 12CH	50.94 b	458.43 b	2.89 b	26.00 b
HD 12CH	31.57 b	284.15 b	2.11 b	19.00 b
Control	22.84 b	205.61 b	1.26 b	11.00 b
		Industry fruits		
Kali 12CH	19.72 a	177.47 a	2.78 ns	25.00 a
Sulp 12CH	21.71 a	195.42 a	3.33	30.00 a
Phos 12CH	19.94 a	179.42 a	3.22	29.00 a
Merc 12CH	14.71 b	132.36 a	1.78	16.00 b
Natu 1 2CH	16.60 b	149.37 a	1.33	12.00 b
Calc 12CH	17.72 b	159.50 a	2.13	19.00 b
Sili 12CH	11.29 b	101.64 a	1.11	11.00 b
HD 12CH	9.76 b	87.87 b	2.12	18.00 b
Control	8.66 b	77.93 b	2.44	22.00 a

Means followed by the same letter in the columns do not differ according to Dunnett test ($p < 0.05$); ns = not significant; Significant at the 5% probability level ($p < .05$); DHD's: Kali = *Kali Carbonicum, Sulp = Sulphur, Merc = Mercuriuns solubilis, Phos = Phosphorus, Natu = Natrum muriaticum; Calc = Calcarea carbonica, Sili = Silicea terra, HD= Distilled water dynamized, Control= water*; 12CH= centesimal Hahnemannian; Fresh market fruits and Industry fruits are a market classification term, where commercial (> 12g/fruit) and industry (<12g/fruit).

When contrasting the results, plants treated with *Kali 12CH, Sulp 12CH* and *Phos 12CH* yielded (total production) in average of 25% to 30% more than the control treatment. This was mainly due to the bigger number of commercial fruits. According to Fagherazzi et al (2017), the size of the fruit is a very important feature because large

fruits, in addition to making harvesting and packaging a faster process, have greater value in the consumer market, resulting in greater gains to the farmer. The average commercial fruit weight obtained in this study (14,58g), match the ones of Beacker et al (2016), who found an average fruit weight of 13.97g for the same variety, *Pircinccue,* which has been used in this experiment.

The biostimulator potential from the DHDs on incrementing yield components gives an indication of the impact of this technique could serve. To illustrate that potential, I'll take the productivity parameters from China and USA, the two biggest producers, which estimate a production per plant ranging from 0.5 kg to 1.3kg per plant in a year cycle (SIMPSON, 2018). So, with that in mind and considering the average production obtained with *Sulp 12CH, Phos 12CH* and *Kali 12CH*, each treatment yielded approximately 830g with 9 plants and using the commercial plant population with a density varying from 15 – 21 plants/m2 depending on the cultivation system (REISER JUNIOR et al., 2020), the estimated production would be around 20 ton/hectares. This yield matches the results found by other authors regarding strawberry production in temperate climates (CALLEJA ET AL., 2012; DIEL et al., 2018; ANTUNES et al., 2020).

Agroecological strawberry system systems have lower production costs when compared to industrial ones (TADEU et al., 2010; GONÇALVES et al., 2016), because organic systems tend to rely for regional and on-farming resources regarding inputs, even if they still share the high harvesting costs. In this sense, it would be possible to increase fruit production without increasing the costs of production, as homeopathic preparations are cheap in comparison to other bio-stimulants and amendments (BOFF et al., 2021).

Nonetheless, the results from this study were obtained in a controlled environment and without the combination with other managements, in which case, more studies on the topic should be done. Also, further field trials could offer a better comparison and understating of the phenomena as well as to integrate the DHDs with other well-known organic techniques to increment crop production.

3.4.2. Plat growth

Strawberry growth results are presented in the tables 7 and 8. In 2019, plant height was influenced by the treatment *Sulp 12CH* which obtained the tallest plants (22.67cm), followed closely by *Kali 12CH* (22.32 cm), *Phos 12CH* (22.36 cm) and *Sili 12CH* (22 cm). All four treatments were significantly higher than the control (18.16 cm). In 2021, the plants presented a similar height (± 21 cm), but this time no significant difference was

observed. However, for the other architectural parameters: fresh mass, dry mass, foliar area and number of dead leaves, presented significative differences when compared to the control treatment. Plants treated with *Sulp 12CH* had the highest fresh mass (900.87g) and dry mass (46.11g) and foliar area (35.07 cm^2).

These results support the ones obtained by Bonato et al (2015), who obtained increases in plant height for strawberry plants treated with *Sulphur*. Similarly, Abasolo-Pacheco et al (2020) using *Silicea terra* 12CH, and *Phosphorus* 12CH, increased the plant height but with different crops, specifically cucumber (*Cucumis sativus L.*), turnip (*Brassica napus* L.) and tomato (*Solanum lycopersicum*). Nunes and colleagues (2021) when testing *Kali Carbonicum* 12CH, *Sulphur 12CH, Phosphorus 12*CH also observed increments on the plant height and fresh mass this time on *Hypericum perforatum.*

Table 7 – Growth parameters of strawberries plants treated with dynamized high dilutions (DHD) in Lages-SC/BR, 2019.

DHD	Plant height (cm)	Fresh mass (g/plant)	Dry mass (g/plant)	Foliar area (cm2)	Viable Leaf (nº)	Dead Leaf (nº)
Kali 12CH	22.32 a	623.07 ns	20.52 ns	28.50 ns	24.00 ns	10.41 ns
Sulp 12CH	22.67 a	642.47	20.00	28.76	28.77	11.00
Merc 12CH	20.85 b	559.58	20.80	21.71	20.88	11.00
Phos 12CH	22.36 a	655.75	20.64	29.71	25.33	12.62
Natu 12CH	19.47 b	500.84	18.07	21.97	23.44	19.21
Calc 12CH	20.16 b	418.52	18.71	19.68	23.11	14.42
Sili 12CH	22.00 a	637.34	21.01	29.92	26.00	12.63
HD 12CH	20.56 b	443.22	19.51	19.30	23.11	11.01
Control	18.16 b	525.65	18.38	19.54	23.77	17.41

Means followed by the same letter in the columns do not differ by Dunnett's test ($p < 0.05$); ns = not significant; Fresh mass = whole plant; Dry mass = whole plant; Viable leaf= average number of leaf's/plants; Dead leaf's = average number of dead leaf's accumulated during the crop cycle. DHDs: Kali = *Kali Carbonicum, Sulp = Sulphur, Merc = Mercuriuns solubilis, Phos = Phosphorus, Natu = Natrum muriaticum; Calc = Calcarea carbonica, Sili = Silicea terra, HD= Distilled water dynamized, Control= water*; 12CH= centesimal Hahnemannian

Table 8 - Growth parameters of strawberry plants treated with dynamized high dilutions (DHD) in Lages-SC/BR, 2021.

DHD	Plant height (cm)	Fresh mass (g/plant)	Dry mass (g/plant)	Foliar area (cm2)	Viable Leaf (nº)	Dead Leaf (nº)
Kali 12CH	23.44 ns	754.67 a	39.38 a	30.23 a	34.12 ns	02.00 b
Sulp 12CH	20.17	900.87 a	46.11 a	35.80 a	38.73	01.89 b
Merc 12CH	21.55	599.11 a	36.40 a	22.08 a	30.14	02.78 a
Phos 12CH	22.40	795.78 a	31.40 a	27.16 a	35.07	01.78 b
Natu 12CH	21.47	473.53 b	21.63 b	18.33 b	33.81	03.33 a
Calc 12CH	21.90	558.14 a	34.19 a	22.98 a	33.28	02.00 b
Sili 12CH	22.12	470.41 b	21.98 b	17.29 b	36.12	06.63 a
HD 12CH	20.02	393.14 b	19.56 b	15.44 b	33.14	05.22 a
Control	19.56	374.95 b	17.89 b	12.51 b	33.87	04.33 a

Means followed by the same letter in the columns do not differ by Dunnett's test ($p < 0.05$); ns = not significant; Fresh mass = whole plant; Dry mass = whole plant; Viable leaf= average number of leaf's/plants; Dead leaf's = average number of dead leaf's accumulated during the crop cycle. DHDs: Kali = *Kali Carbonicum, Sulp = Sulphur, Merc = Mercuriuns solubilis, Phos = Phosphorus, Natu = Natrum muriaticum; Calc = Calcarea carbonica, Sili = Silicea terra, HD= Distilled water dynamized, Control= water*; 12CH= centesimal Hahnemannian

The positive effects of *Sulphur* 12CH on plant growth was also observed in other crops like radish (*Raphanus sativus L.),* where Bonato et al (2003) verified increments in fresh and dry matter mass and leaf area. Interestingly, Pulido and colleagues (2017) witnessed the positive effects of *Sulphur,* but these authors used the potency 30CH to increase plant height, dry and fresh mass in broccoli (*Brassica oleraceae var. italica*).

The data observed in this study support other studies who verified the positive influence of DHDs in promoting plant growth and development (JÄGER et al., 2015; TEIXEIRA et al., 2017; ÜCKER et al., 2018). The DHDs could be used as plant biostimulator and management tool in order to help crops to optimise their natural development. For example, the plant height can be an advantageous strategy for plants to intercept more light, which favors their photosynthetic machinery, therefore, helping them to maintain sufficient levels of photosynthesis activity (TAIZ et al., 2017).

3.4.3. Morphophysiological development

The Morphophysiological development are presented in the tables 9 and 10. The morphophysiological parameters such as number of flowers, production of stolon, crown development and leaf chlorophyll content are important for the strawberry culture

because they are directly linked to crop production and crop health (FAGHERAZZI et al., 2021).

Overall, in 2019, plants treated with *Sulp 12CH* (Ø 6.68 cm) developed the biggest crown diameter when compared with the control treatment (Ø 4.58 cm). Similarly, plants treated with *Phosp 12CH* also developed vigorous crowns (Ø 6.66 cm). In 2021, *Sulp 12CH* (Ø 6.69) and *Phos 12CH* (Ø 5.42) once again promoted plants with bigger crown diameter.

Strawberry plants with bigger crown diameter (figure 23) are known to be taller and more productive plants (FAGHERAZZI et al., 2021; DE LIMA et al., 2021). According to Cocco et al (2015), plants that have larger crown diameters have more energy reserves in the form of starch. As a consequence of that, plants with bigger crown diameter are more likely to have a higher number of buds capable of differentiating into flowers, resulting in and increases in the number of fruits per plant.

The crowns have the function of regulating the metabolic activities of strawberry plants, being the main energy storage organ (FAGHERAZZI et al., 2021). In this case, bigger crowns confer an advantage for the plant, accumulating more carbohydrates, leading to larger plants, increasing in the plant's biomass and the capacity to mobilize reserves for the fruit set (COCCO et al., 2016).

Table 9 - Morphophysiological parameters of strawberry plants treated with dynamized high dilution (DHD) in Lages-SC/BR, 2019.

DHD	Stolon (nº)	VF (nº)	DF (nº)	SPAD (unit)	Crown (Ø cm)
Kali 12CH	1.00 b	2.00 ns	0.16 b	53.06 b	5.26 b
Sulp 12CH	5.00 a	2.00	0.17 b	54.57 a	6.68 a
Merc 12CH	1.00 b	1.33	0.17 b	53.17 b	5.68 b
Phos 12CH	5.20 a	1.33	0.28 b	54.71 a	6.66 a
Natu 12CH	1.44 b	1.22	0.33 a	51.70 b	5.66 b
Calc 12CH	1.33 b	2.11	0.17 b	51.96 b	5.50 b
Sili 12CH	1.00 b	2.11	0.16 b	54.69 a	5.95 b
HD 12CH	1.00 b	2.00	0.20 b	51.70 b	5.57 b
Control	1.00 b	1.22	0.16 b	52.24 b	4.58 b

Means followed by the same letter in the columns do not differ by Dunnett's test ($p < 0.05$); ns = not significant; Stolon= total production/plot; VF= viable flowers/assessment; DF; death flowers/assessment; SPAD= chlorophyll concentration in SPAD units. DHDs: Kali = *Kali Carbonicum, Sulp = Sulphur, Merc = Mercuriuns solubilis, Phos = Phosphorus, Natu = Natrum muriaticum; Calc = Calcarea carbonica, Sili = Silicea terra, HD= Distilled water dynamized, Control= water*; 12CH= centesimal Hahnemannian

Table 10 - Morphophysiological parameters of strawberry plants treated with high dynamized dilution (DHD) in Lages-SC/BR, 2021.

DHD	Stolon (nº)	VF (nº)	DF (nº)	SPAD (unit)	Crown (Ø cm)
Kali 12CH	1.22 b	4.00 ns	0.11 b	50.15 a	5.21 a
Sulp 12CH	4.45 a	4.77	0.22 b	55.67 a	6.69 a
Merc 12CH	1.44 b	4.56	0.11 b	43.22 b	4.04 b
Phos 12CH	1.33 b	4.78	0.11 b	44.31 b	5.42 a
Natu 12CH	1.11 b	2.78	1.12 a	41.10 b	3.93 b
Calc 12CH	1.11 b	4.33	0.10 b	41.36 b	3.81 b
Sili 12CH	1.44 b	4.11	0.33 b	44.39 b	3.86 b
HD 12CH	1.60 b	4.10	1.13 a	41.71 b	3.19 b
Control	1.00 b	3.56	1.78 a	42.54 b	3.63 b

Means followed by the same letter in the columns do not differ by Dunnett's test ($p < 0.05$); ns = not significant; Stolon= total production/plot; VF=viable flowers/assessment; DF; death flowers/assessment; SPAD= chlorophyll concentration in SPAD units. DHDs: Kali = *Kali Carbonicum, Sulp = Sulphur, Merc = Mercuriuns solubilis, Phos = Phosphorus, Natu = Natrum muriaticum; Calc = Calcarea carbonica, Sili = Silicea terra, HD= Distilled water dynamized, Control= water*; 12CH= centesimal Hahnemannian

The results of crown diameter help to explain the stolon production data. The stolons are a vegetative structure (two-node - axillary shoot), whose main function is the natural clonal multiplication capacity (SAVINI et al., 2008). The production of stolons may play an important role for improving nursery plant production. In 2019, plants treated with *Sulp 12CH* (5.00) and *Phos 12CH* (5.20) produced more stolons when compared to any other treatments. In 2021, *Sulp 12CH* (4.45) again extimulated stolon production. However, plants produced less stolons when comparing data of 2019.

Figure 22 - Strawberry crown diameter and stolon assessment

Source: developed by the author (2022).

The data from crown diameter and stolon production is relevant for examining the SPAD results presented in the tables 9 and 10. In, 2019 plants treated with *Sulp 12CH* (54.57), *Phos 12CH* (54.71) and *Sili 12CH* (54.69) obtained higher SPAD units when compared to the control treatment (52.24). Interestingly, in 2021 strawberry plants treated with *Sulp 12CH* (55.67) again had higher content of chlorophyll in its leaves when compared to the control (42.54).

The connection between the SPAD reading and the leaf's chlorophyll content in strawberry plants has been widely studied (MARTINEZ et al., 2017). The chlorophyll content is related to the Nitrogen concentration in the leaf, which is fundamental to the photosynthetic apparatus, reflecting the plant's capacity to produce carbohydrates (TAIZ, 2017).

The higher chlorophyll content in the leaves was verified in the plants that had bigger crown diameter and height. Massetani and Neri (2016) observed that taller plants tend to intercept more light photons therefore, the chlorophyll content in the leaf will be higher than in smaller plants. In the same sense, plants with bigger crown diameter are an indicator that the photosynthesis activity is performing well, as the photo-assimilates are storage in that structure, and it increases its diameter in order to store those photo-assimilates (FAGHERAZZI et al., 2021).

Having plants with vigorous crowns will allow the crop to accumulate and distribute energy resources throughout the growing season, mainly by accumulating more starch. This will help the plants to be more productive and having a reliable source of energy in case of stress. Fagherazzi and colleagues (2021) have explained that plants with bigger crown diameter (over 5 cm) are more productive and can overcome environmental stress like drought periods more efficiently.

In addition, incrementing stolon production is an important feature because it might help strawberry farmers to enhance their capacity to produce their own seedlings, thus minimizing their production costs. For instance, in Brazil, around 300 million strawberry plants are needed annually to meet farmers' demand (ANTUNES et al., 2020).

However, it's important to mention that there could be some limitations on producing one's seedling. On one hand the farmer lowers their costs and has an adapted genetic material to its local condition, on the other hand there could be limitation to the number of seedlings produced as well as in the crown diameter of these seedlings, factors that could compromise the production (MEZZETTI et a., 2018; ANTUNEs et al., 2020).

In this sense, the use of DHDs as *Sulp 12CH* and *Phos 12CH* would help the strawberry plant to achieve such desirable morphophysiological features.

If then we take in account the growth and morphophysiological development of plants treated with *Sup 12CH, Phos 12CH, Kali 12CH and Calc 12CH,* we can assume that the plant physiology was operating in an optimum level of activity, meaning balanced plants.

As a consequence of this growth promotion on vegetative and reproductive organs, it was expected to observe responses on the plant root system too. The next topic will discuss the rhizosphere development.

3.4.4. Root system development

The root system architecture and development are presented in the tables 11 and 12. The root system play a fundamental role concerning water and nutrient intake as well as for the association with the soil biological community. Such features influence the resilience of strawberries to environment stress (DONG. et al. 2020).

In 2019, plants treated with *Sulp 12CH* (0.71 Ø mm), *Calc 12CH* (0.70 Ø mm) and *Sili 12CH* (0.75 Ø mm) developed roots with bigger diameters when compared to the control treatment (0.63 Ø mm). In addition, *Calc 12CH* increased the root volume of strawberry plants (47.51 Ø mm) when compared to the control treatment (36.49 Ø mm). There were no differences regarding the length/volume ($\bar{x}$ 23.21 cm^2), length ($\bar{x}$ 82.28 cm), projected/area ($\bar{x}$ 37.60 cm^2), surface ($\bar{x}$ 12.17 cm^2).

In 2021, all the tested DHDs increased strawberry root system architecture and development when compared to the control. Noticeably, plants treated with *Sulp* presented higher ratio length/volume (23.87cm^3), longer roots (85.63 cm), bigger volume (94.56 cm^3), with a wider projected area (33.64 cm^2) and surface area (31.95 cm^2).

Table 11 - Architecture and development of strawberry root system treated with dynamized high dilutions (DHD). Lages-SC/BR, 2019.

DHD	Len/vol (cm^3)	Length (cm)	Root volume (cm^3)	Avg/Diam (Ø mm)	Projc/area (cm^2)	Surface (cm^2)
Kali 12CH	23.98^{ns}	80.80 ^{ns}	39.56 b	0.65 b	38.02 ^{ns}	11.94 ^{ns}
Sulp 12CH	24.26	78.76	45.45 b	0.71 a	37.03	13.41
Merc 12CH	25.43	91.56	37.32 b	0.66 b	41.94	12.17
Phos 12CH	20.22	75.90	29.52 b	0.66 b	33.47	10.51
Natu 12CH	23.58	73.79	29.50 b	0.66 b	36.53	11.89
Calc 12CH	18.69	88.40	47.51 a	0.70 a	39.12	12.51
Sili 12CH	24.13	87.98	43.13 b	0.75 a	43.93	13.80
HD 12CH	25.28	83.61	39.38 b	0.68 b	35.37	12.59
Control	23.34	79.72	36.49 b	0.63 b	34.19	10.74

Means followed by the same letter in the columns do not differ by Dunnett's test ($p < 0.05$); ns = not significant. DHDs: Kali = *Kali Carbonicum, Sulp = Sulphur, Merc = Mercuriuns solubilis, Phos = Phosphorus, Natu = Natrum muriaticum; Calc = Calcarea carbonica, Sili = Silicea terra, HD= Distilled water dynamized, Control= water*; 12CH= centesimal Hahnemannian

These results are supported by a series of findings from other studies which also found a positive influence of *Sulphur,* in different crops and potencies, promoting root system development (BONATO et al., 2003; MODOLON et al., 2011; PULIDO et al., 2017). However, this study contrast with Lensi et al (2010) who observed root development in beans (*Phaseulus vulgaris L)* using *Naturum muriaticum, but* these authors used 6CH. In the same way, Hans et al (2020) verified that *Calcaria carbonica* 6CH improved the roots system of lettuce (*Lactuca sativa L.*) in toxic conditions rich in Al. Furthermore, Jägger et al (2015) had positive results with *Phosphorus*, *Silicia* and *Kali* as root system growth promoters.

Table 12 - Architecture and development of strawberry root system treated with dynamized high dilutions (DHD). Lages-SC/BR, 2021.

DHD	Len/vol (cm^3)	Length (cm)	Root volume (cm^3)	Avg/Diam (Ø mm)	Projc/area (cm^2)	Surface (cm^2)
Kali 12CH	20.11 a	72.42 a	76.71 a	0.65 b	26.43 a	28.40 a
Sulp 12CH	23.87 a	85.63 a	94.56 a	0.71 a	33.64 a	31.95 a
Merc 12CH	17.88 a	64.38 a	60.03 b	0.66 b	22.10 a	25.97 a
Phos 12CH	19.19 a	65.49 a	60.97 b	0.66 b	22.47 a	26.12 a
Natu 12CH	16.36 a	57.62 b	69.67 a	0.66 b	22.42 a	26.06 a
Calc 12CH	19.91 a	69.47 a	76.17 a	0.70 a	25.12 a	28.28 a
Sili 12CH	17.13 a	61.35 a	64.42 a	0.75 a	22.45 a	26.19 a
HD 12CH	10.97 b	40.17 b	44.01 b	0.68 b	14.82 b	12.59 b
Control	09.59 b	35.60 b	29.76 b	0.63 b	11.41 b	18.67 b

Means followed by the same letter in the columns do not differ by Dunnett's test ($p < 0.05$); ns = not significant. DHDs: Kali = *Kali Carbonicum, Sulp = Sulphur, Merc = Mercuriuns solubilis, Phos = Phosphorus, Natu = Natrum muriaticum; Calc = Calcarea carbonica, Sili = Silicea terra, HD= Distilled water dynamized, Control= water*; 12CH= centesimal Hahnemannian

To grow a strawberry crop, normally seedlings are transplanted from the nurseries (DONG et al 2020). This management action is critical, because the shock of the transplanting can potentially compromise the viability of the seedlings and crop development (KUMAR and DEY., 2011). Transplant shock usually occurs after transplanting, including symptoms like leaf wilt or death, alteration of metabolic processes and cessation of seedling growth or death of it and further plant development (LI et al., 2016). Overcoming transplanting shock via root growth recovery is important to restore growth and development in a short period of time.

The results of this research suggest that strawberry plants treated with DHDs helped the plants to overcome that critical stage, acting as plant-biostimulator leading to a robust root system development. Other authors have verified similar results. Bonato et al., (2003) increased the root development of radish (*Raphanus sativus)* using *Sulphur* 12CH, whereas Pullido et all (2014) incremented the root system and the number of viable seedlings of cabbage (*Brassica oleracea var. capitata*) using *Sulphur* 6CH and *Silicea* 30CH. In further studies, Pullido et al (2017) incremented broccoli (*Brassica oleracea var. itálica*) root system with *Suplhur* 30CH.

In contrast, this study differs from the results obtained from Bonfin et al (2010) who obtained no response in root growth parameters when using *Calacaria cabonica* 12CH. Similarly, my results also vary from Fonseca et al (2006) who used *Calcaria* 6Ch and *Silicea* 6CH. However, these authors used a single application of the DHD whereas in my study the DHD was applied fortnight. These results suggest that a more constant application could potentially sensitize plants in a more efficient way.

Other authors studying root system development via a metabolic point view, argues that DHD acts by accelerating plant metabolism (BONATO et al., 2003; TEIXEIRA et al., 2017), that the DHD led to a higher response in terms of auxin production, promoting root growth through the polar transportation coupled with gibberellin (GA) functioning in root cells (DONG et al., 2020). In roots, auxin increases root hair length, diameter and consequently its volume (LI et al., 2016). The efficiency of plant roots to get access to water and nutrients is determined by root system architecture and, it plays a significant role in determining crop success (SHAHZAD and AMTMANN, 2017).

Capra and colleagues (2014) argue that the application of homeopathic preparations unleash plant responses, redirecting metabolic pathways towards plant growth. Supporting that argument, Duarte (2007) increased growth in eucalyptus (*Eucalyptus citriodora and Eucalyptus globulus*) using *Phosphorus* 12CH. In the same way Santos et al (2011) promoted growth of *Verbena gratissima* using *Phosphorus 9CH*, while Bonato (2009) incremented plant growth in mint (*Mentha arvensis L.*) using *Sulphur* 12CH.

Overall, the positive responses observed in the growth and development of strawberry plants treated with DHDs allows this study to argue that the mineral dynamized high dilutions as well as the 12CH potency tends to be effective in stimulating the plants.

The next section analyzes the fruit quality data.

3.4.5. Fruit quality

The fruit quality results are presented in tables 13 and 14. Overall, the fruits produced in this study had deep red colour (1.69 hº), with brilliant epidermis (33.37 L) and medium colour saturation (46.97 %). Its sugar content indicates sugary fruits (5.51º) with moderate acidity (0.57). The pulp firmness levels (1.72 N), indicate firm texture, therefore good shelf/package life.

In 2019, the influence of the DHDs on the fruit quality could not be verified. In 2021 however, fruits from plants treated with DHDs had significantly firmer pulp (± 2.59 N) when compared to the control (1.62 N). In addition, the application of *Kali* 12CH (6.29) and *Sili 12CH* (6.23) produced fruits with less acidity. Furthermore, *Sulp 12CH* (6.42º), *Phos 12CH* (6.18 º) and *Calc 12CH* (7.76 º) obtained the highest brix levels. These results help to build up the still scarcely data regarding the positive effects of DHD on fruit quality. Other studies which mention positive effects are Rubinkienė et al (2014) where soluble solids were increased using *Silicea terra* 30CH in sweet pepper (*Capsicum annuum* L.), and Sakalauskiené et al (2011) where firmer pulp in tomatoes were obtained using nosode of *Ocimum basilicum* L 30CH.

On the other hand, it was possible to compare this study results with others that evaluated strawberry fruit quality (KUMAR et al., 2018; BARTH et al., 2019). According

to Fagherazzi et al (2017), fruits with firmer pulp and colour are highly demanded by the market.

Table 13 - Fruit quality parameters from strawberry plants treated with high dynamized dilutions (DHD). Lages-SC/BR, 2019.

DHD	SSº	TA	PF	Colour		
				C	L	hº
Kali 12CH	6.77 ns	5.55 ns	1.83 ns	45.67 ns	33.34 ns	1.69 ns
Sulp 12CH	7.50	5.54	1.89	47.42	33.81	1.71
Merc 12CH	6.63	5.58	1.72	49.27	33.68	1.69
Phos 12CH	6.33	5.62	1.61	47.06	32.72	1.69
Natu 12CH	7.60	5.62	1.39	47.91	33.72	1.69
Calc 12CH	7.13	5.56	1.84	50.12	34.45	1.71
Sili 12CH	6.68	5.59	1.61	45.53	32.51	1.69
HD 12CH	6.75	5.61	1.94	43.89	32.32	1.69
Control	7.65	5.54	1.71	45.91	33.49	1.70

Means followed by the same letter in the columns do not differ by Dunnett's test ($p < 0.05$); ns = not significant; SS=Brixº; TA = Titratable acidity; PF= Pulp firmness, the strength necessary to break fruit epidermis in Newton (N); Colour: L expresses luminosity on a scale ranging from 0, corresponding to black, to 100 corresponding to white; C expresses colour saturation, from a scale ranging from 0 to 100%; h ° defines the basic colour, where 0 ° = red, 90 ° = yellow and 180 ° = green. DHDs: Kali = *Kali Carbonicum, Sulp = Sulphur, Merc = Mercuriuns solubilis, Phos = Phosphorus, Natu = Natrum muriaticum; Calc = Calcarea carbonica, Sili = Silicea terra, HD= Distilled water dynamized, Control= water*; 12CH= centesimal Hahnemannian

Table 14 - Fruit quality parameters from strawberry plants treated with high dynamized dilutions (DHD). Lages-SC/BR, 2021.

DHD	SSº	TA	PF	Colour		
				C	L	hº
Kali 12CH	6.08 b	6.29 a	2.69 a	42.49 ns	39.54 ns	1.79 ns
Sulp 12CH	6.42 a	6.11 b	2.75 a	41.63	39.62	1.61
Merc 12CH	5.87 b	5.38 b	2.79 a	42.35	39.70	1.77
Phos 12CH	6.18 a	5.71 b	2.65 a	43.13	39.80	1.79
Natu 12CH	5.85 b	5.63 b	2.28 a	43.51	40.09	1.84
Calc 12CH	7.76 a	5.94 b	2.34 a	42.50	40.08	1.75
Sili 12CH	5.91 b	6.23 a	2.68 a	43.24	40.49	1.89
HD 12CH	5.18 b	5.34 b	1.51 b	42.47	38.40	1.79
Control	5.16 b	5.55 b	1.62 b	42.43	37.93	1.75

Means followed by the same letter in the columns do not differ by Dunnett's test ($p < 0.05$); ns = not significant; SS=Brixº; TA = Titratable acidity; PF= Pulp firmness, the strength necessary to break fruit epidermis in Newton (N); Colour: L expresses luminosity on a scale ranging from 0, corresponding to black, to 100 corresponding to white; C expresses colour saturation, from a scale ranging from 0 to 100%; h ° defines the basic colour, where 0 ° = red, 90 ° = yellow and 180 ° = green. DHDs: Kali = *Kali Carbonicum, Sulp = Sulphur, Merc = Mercuriuns solubilis, Phos = Phosphorus, Natu = Natrum muriaticum; Calc = Calcarea carbonica, Sili = Silicea terra, HD= Distilled water dynamized, Control= water*; 12CH= centesimal Hahnemannian

As a consequence of having a good growth and development, the strawberry plants tend to be more productive and have good fruit quality. The data analyzed in this did expressed fruits with characteristics very desirable for the market regarding vibrant colour, with deep red (± 1.69 hº), with brilliant epidermis (± 33.37 L) and medium colour saturation (± 46.97 %). In addition, its sugar content indicates sugary fruit (± 5.51º) with moderate acidity (± 5.57). These features are crucial to help farmers to produce high quality fruits (GIAMPIERI et al., 2014), which will help them to secure good prices paid for the fruit, rewarding farmers with good income. If we examine the pulp firmness levels (± 1.72 N) which indicate firm texture, that could also help retailers and consumers with a reasonable window in terms of good shelf/package life.

3.4.6. Incidence and severity of pest and disease

Table 15 and 16 shows the results regarding the strawberry pathosystem dynamic over the incidence and severity of pest and disease. In 2019, plants treated with *Sulp 12CH* (1.76) and *Sili 12CH* (1.69) were less affected by leaf spot disease when compared to the control (2.33). There was no significative difference regarding the disease severity. In the same way, no difference was observed regarding incidence and severity of spider mite.

Table 15 - Pathosystem dynamic (incidence and severety) of leafspot and spider mite in strawberry plants treated with dynamized high dilutions (DHD). Lages-SC/BR, 2019.

Treatment	DI	DS	PI	PS
Kali 12CH	2.31 a	0.98 ^{ns}	2.49^{ns}	2.06 ^{ns}
Sulp 12CH	1.76 b	1.06	2.13	1.77
Merc 12CH	2.30 a	1.02	3.20	2.65
Phos 12CH	2.32 a	0.98	2.48	2.06
Natu 12CH	2.22 a	0.97	3.20	2.65
Calc 12CH	2.30 a	1.01	2.84	2.06
Sili 12CH	1.69 b	1.25	3.20	2.65
HD 12CH	2.31 a	1.03	2.84	2.35
Control	2.33 a	0.98	2.49	2.06

Means followed by the same letter in the columns do not differ by Dunnett's test ($p < 0.05$); ns = not significant; DI= disease incidence; DS= foliar disease severity; PI= foliar pest incidence; PS =foliar pest severity. DHDs: Kali = *Kali Carbonicum, Sulp = Sulphur, Merc = Mercuriuns solubilis, Phos = Phosphorus, Natu = Natrum muriaticum; Calc = Calcarea carbonica, Sili = Silicea terra, HD= Distilled water dynamized, Control= water*; 12CH= centesimal Hahnemannian

In 2021, all strawberry plants treated with DHDs were less affected by leaf spot disease when compared to the control. Once again *Sulp 12CH* (1.67) and *Sili 12CH* (1.69) obtained minor disease scores than the control (5.22). There was no difference concerning the disease severity. In addition, plants treated with the DHDs were less attacked by spider mite. Noticeably, *Sulp 12CH* obtained the minor scores of incidences (0.78) and severity (1.10) when compared with the control (3.56 - 5.67).

The results of the pathosystem dynamic could be explained via plant defense mechanisms. Deboni et al (2021) verified in their study with beans, that homeopathic preparations have the potential to induce biochemical defense mechanisms in the plant, acting as resistance elicitors. However, in my study I didn't perform any analyze in that regard. I did though, assessed crop vigour and development, that according to Brugnara et al (2014) also explain less disease in the plants.

The crop development promoted by DHDs as verified in this study, especially regarding the biometric parameters as presented in the sections above, supports this claim. Mezzetti (2018) and Hancock (2020) also support that vigorous plants, will led to more to pest/disease resistant plants.

Table 16 - Pathosystem dynamic (incidence and severety) of leafspot and spider mite in strawberry plants treated with dynamized high dilutions (DHD). Lages-SC/BR, 2021.

Treatment	DI	DS	PI	PS
Kali 12CH	2.78 b	3.00 ^{ns}	1.13 b	1.10 b
Sulp 12CH	1.67 b	2.56	0.78 b	1.01 b
Merc 12CH	3.11 b	3.11	1.11 b	1.56 b
Phos 12CH	2.22 b	2.11	1.28 b	1.33 b
Natu 12CH	2.56 b	2.78	1.33 b	2.67 b
Calc 12CH	2.33 b	1.67	1.56 b	2.06 b
Sili 12CH	1.69 b	2.89	1.33 b	1.89 b
HD 12CH	4.56 a	4.78	3.22 a	3.22 a
Control	5.22 a	9.44	3.56 a	5.67 a

Means followed by the same letter in the columns do not differ by Dunnett's test ($p < 0.05$); ns = not significant; DI= disease incidence; DS= foliar disease severity; PI= foliar pest incidence; PS =foliar pest severity. DHDs: Kali = *Kali Carbonicum, Sulp = Sulphur, Merc = Mercuriuns solubilis, Phos = Phosphorus, Natu = Natrum muriaticum; Calc = Calcarea carbonica, Sili = Silicea terra, HD= Distilled water dynamized, Control= water*; 12CH= centesimal Hahnemannian

3.5. CONCLUSION

The result of this study shows that the application of dynamized high dilutions (DHDs) have the potential to act as plant biostimulators and promote agronomical responses and stimulate vitality of strawberry plants (*Fragaria × ananassa).*

The results of this research suggest that dynamized high dilutions of Sulfur, Potassium, Phosphorus increased the yield, plant height, crown diameter, leaf chlorophyll content and production of stolons in strawberry plants. Furthermore, dynamized high dilutions of Silicon and Calcium positively influenced the development and architecture of the strawberry root system, particularly in root volume, root diameter and surface.

The potency 12CH used in this study showed positive results for nexus crop x DHD, predominantly for the mineral high dynamized dilutions and could be used as reference for further studies testing DHD in other crops. In addition, the DHDs with the best results obtained in this research should be tested in field conditions to expand the data on the use of DHD as plant bio-stimulators.

The results show that dynamized high solutions (DHD) is a sustainable and safe alternative that could help farmers to achieve appropriate yields and crop development without mitigating the problems related to the use agrochemicals. This study offers results related to the salutogenic approach to agriculture and the management of sustainable strawberry cropping systems. Furthermore, the result of this study shows that the use of dynamized high dilutions could be used as sustainable a management tool. One that could be included in the strategies for a sustainable management of the strawberry culture, providing farmers with a useful and safe technology to be used in the field. Hence supporting the production of agroecological food systems and strategies.

4. THE USE OF HOMEOPATHY AND DYNAMIZED HIGH DILUTIONS IN AGRICULTURE AND THE VITALITY PERCEPTION: A FARMERS' SURVEY PERSPECTIVE

4.1. ABSTRACT

Homeopathy and the use of dynamized high dilutions in agriculture are innovative tools that aims to promote vitality in agriculture. However, there is a knowledge gap regarding research results and the reality experienced in the field by farmers who utilize the method. Therefore, the objective of this study was to comprehend what is the experience of farmers who are using homeopathy and high-dynamized dilutions. To do so, a web-survey was circulated with farmers who utilized high-dynamized solutions in agriculture. The farmers were contacted through social media platforms on social media groups specifically dedicated to the use of homeopathy on the agroecosystem and/or high-dynamized dilutions. The survey was developed and analyzed using the Dashboard platform© (JISC online surveys). Overall, the participants who completed the survey could be described as: a) experienced in the use of the technic (49% are using it for more than 10 years); identify themselves as independents, not relaying on certification stamps (60%) but rather in their farming profile, mainly described (72%) as non-chemical, agroecological, regenerative organic and permacultural; b) autonomous and pragmatic when seeking for technical advice, preferring books (62%) and peer-exchanges (45%); c) The HDDs used in this study's controlled experiments are commonly used by these farmers; d) that HDDs user perceived improvements on crop (80%), livestock (40%), ecosystem (77%) and human health (67%). In addition, they reported reduction on their production costs (49%), higher yields (46%); e) that their main reasons for using high-dynamized dilutions is because that are an environmentally friendly (32%), with impacts in their health (26%) and potential benefits for society (22%). Furthermore, 14% of the respondents stated spiritual reasons for using them; f) Farmers experience and perception of vitality is a very personal, subjective but still pragmatic way with consequences to ontological perspectives towards the man-nature relationship.

KEYWORDS: Ultra dilutions; Vitality; Farmers-experience; Survey

4.2. INTRODUCTION

Following on from the previous chapter where the trials to assessed agronomic responses of dynamized high dilutions (DHDs) on strawberry culture, the next chapter introduce and details the experience of farmers on using the method helping to address the research question "*How do farmers experience the used of Homeopathy and dynamized high dilutions in agriculture*? In this chapter, farmers' experience on the use of homeopathy and high-dynamized dilutions and their perception on vitality are examined.

4.2.1. The use of Homeopathy in agriculture and vitality perception: a farmer's survey

Homeopathy has been applied to balance living organisms' dynamics and promote the sustainability of the agroecosystem (CORREOSO et al, 2022). However, the effectiveness of homeopathic therapy in agriculture is dependent on the perception of the agroecosystem relationships at different levels of the system, practitioner's experience, and local contextualisation, (BOFF, 2009). The farmers' perspectives in particular, when considered to build technical knowledge can help to connect knowledge gaps between research data and field reality, helping to establish dialogues and promoting beneficial social changes (FREIRE, 1985).

Homeopathy is at the same time a technical and social technology (KHOLER and NEGRÃO, 2018), and undoubtedly it presents an epistemological challenge to conventional farming due to its non-orthodoxically (ANDRADE and CASALI, 2011). Therefore, building up evidence based both on practical and research, natural and social perspectives is crucial for the development, applicability, and comprehension of any agricultural research (NUIJTEN, 2011).

4.3. METHODOLOGY

Online surveys were chosen for this research because it was a suitable method to collect data in times of lockdown (2020 - due to COVID-19 world pandemic) while reaching a large amount of information sources/participants.

Over the last decades, technology has revolutionized the way in which surveys are administered. Some authors argue that most of all survey research will be done online in the future (EVANS AND MANTHUR, 2005). Online surveys offer a series of advantages for research: wide reach; flexibility in their formats such as e-mail with embedded survey or e-mail with a link to a survey URL; and ease of data entry and analysis where the researcher instantaneously has all the data stored in a data base (GIDEON et al., 2012).

Online surveys are capable of including dichotomous questions, multiple-choice questions, scales, questions in a multimedia format, both single-response and multiple-response questions, and even open-ended questions (PETROVČIČ et al., 2014). Speed and timeliness are also important, and online surveys can be administered in a time-efficient manner, minimizing the period it takes to get a survey into the field and for data collection (GIDEON et al., 2012). On the other hand, some issues have to be born in mind: low rate of response, incomplete or limited online data bases, survey length, privacy and security issues, impersonality (GLAS et al., 2019).

To undertake an online survey for this research, social groups specifically dedicated to the use of homeopathy on the agroecosystem and/or to biodynamic farming were selected on social media platforms. As previously explained in the general introduction, both methods share many methodological similarities, including the use of high-dynamized dilutions to promote vitality in the agroecosystem. Also, it worth mentioning that no strawberry farmers group were target because not a large number of farmers are using DHDs and there was no target online user group for them.

These groups were selected using the snowball method, whereby one known group was examined and through this a second group was found, which then led to a third group and so on. The groups are operating on an international level. The social media platform Facebook® was chosen because of its number of active users, around of 2.8 billion covering 57% of the world's 4.9 billion internet users (STATISTA, 2020).

A total of 20 groups were selected (link for the groups can be found in the appendix A), as shown in the list of groups in the Table 17. These groups were characterized based on 3 criteria: a) whether the content was controlled – so no social media spam or companies' sponsored content were allowed. Only participants reports, experiences and suggestions were accepted in the information feed; b) The core discussion theme – the content were exclusively focus on homeopathy, biodynamic farming and/or high-dynamized dilutions in agriculture; c) whether they were open or closed - There were filters regarding the acceptance of participants which had to answer

a series of questions regarding interest and justification to be admitted in the group thus selecting real interested people on the subject.

These features are important for this research, because they helped to establish a focused data source regarding people with real experience and interest on the subject of Homeopathy and dynamized high dilutions (DHDs) on agriculture. It also helped me reach out this research target group: farmers.

As some members of these groups may not be farmers, the front page of the survey was designed to select only farmers from amongst the group participants. The survey was translated into six languages (English, Italian, Portuguese, Spanish, French and German), and kept open from January to April 2021.

The questions were designed to understand farmers' decision making processes; and main motivations to use Homeopathy and dynamized high dilutions (DHD); to identify their successes and difficulties in using these methods; to categorize them regarding their certification status; to identify possible innovations that they might have developed when using homeopathy and DHDs and to explore their understanding of the concept of vitality of the agroecosystem, etc. (see appendix B for the questionnaire). Answers could be compared to determine areas of agreement as well as areas of divergence.

The semi-structured questionnaire was designed to be short, taking 5 minutes to complete. This was because it does not compromise working time, as well as improving engagement ratio (GLAS et al., 2019).).

Before sending the survey to the target groups, it was circulated amongst peer researchers so they could pilot it, helping to identify misleading questions as well as adding precision to the questions designed. It was decided that a semi-structured questionnaire would be ideal because it offers the possibility to answer specific questions by the same time that it leaves spaces for personal statements (PATTON, 2014).

The survey was developed and analysed with the help of the software Dashboard platform© (JISC online surveys). Its content was checked for ethical approval, following confidentiality, anonymously and security features. The participants agreed to sharing their data with this research.

Table 17. Social media groups targeted with the web survey on the uses of Homeopathy and Dynamized High Dilutions by farmers, 2021.

Group Name	Country	Date of creation	Number of members	Access category	Control over members publication
Homeopathy for all	Ger	2011	7,900	private	yes
Homeopathy and Homeopaths	IND	2011	24,600	private	yes
Homeopatia internationala	ITA	2011	1,200	private	yes
Biodynamic Community	GER	2011	6,000	private	no
Homeopatia veterinária	BR	2012	924	private	yes
Agrohomeopathy: homeopathy for farming and garden	UK	2013	4,800	private	no
Biodynamic Agriculture Brazil	BR	2013	373	private	no
Biodynamic Gardening	UK	2015	987	private	yes
Homeopatia na Agroecologia	BR	2015	1,200	public	no
Remedios Naturales Comenius	MEX	2015	9,000	private	yes
Homeopathy	GER	2015	17,600	private	yes
Agricultura Biodinâmica	BR	2016	5,200	Open	Yes
Biodynamic Gardening Group	UK	2016	2,000	private	No
Biodynamic and Beekeeping	UK	2016	1,700	private	yes
Secular Energetic Biodynamics	GER	2017	1,700	public	no
Homeopathy	IND	2017	82,700	Private	yes
Homeopathy 360	USA	2018	10,300	open	yes
Homeopatia	ITA	2018	1,600	private	Yes
IHA – Agrohomeopathy and Veterinary homeopathy	IND	2018	287	public	No
Homeopathy in the garden	USA	2020	493	private	No
Total			Total		
20			97.946,7		

Source: developed by the author (2022).

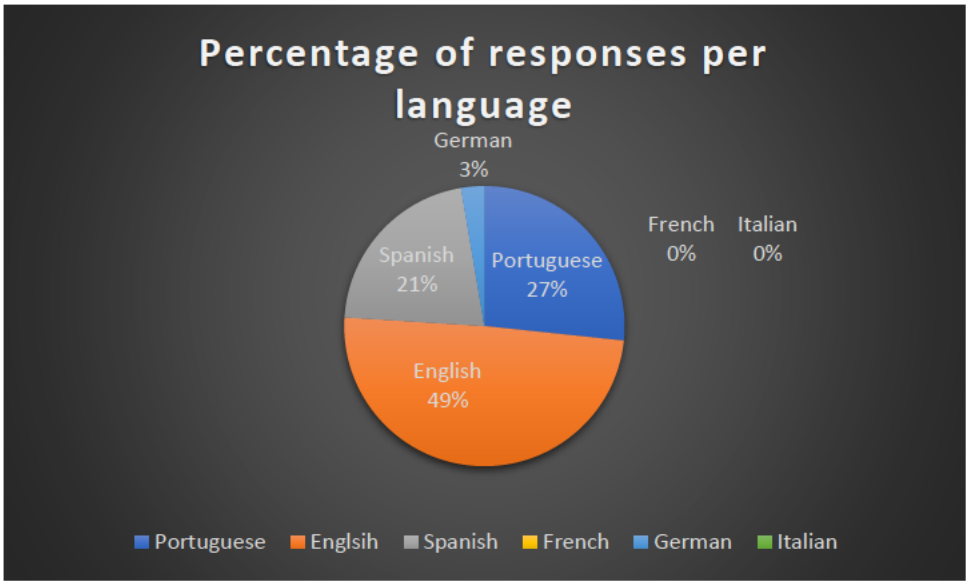
4.4. RESULS AND DISCUSSION

4.4.1. Survey engagement

The survey was responded to by 127 respondents. The survey was made available in 6 languages, and English, Portuguese, Spanish obtained most responses whereas Italian and French got none. The number of participants engaged was considered adequate, as

Petrovčič et al., (2016) argues that over 50 participants could be seen as appropriate number to exemplify a specific scenario or situation. Nevertheless, when analyzing the number of people that could have had responded to it (97.946,7) – considering the sample size of participants on the social media groups until the survey was closed in March 2021- the survey got a low response rate. In fact, this number reflects a reality obtained in other studies. Data suggests that online usage for surveys was hovering around 2% of possible target group (EVANS and MATHUR,2005; LIOR, 2012). Some researchers argue that although we live in an increasingly connected age, people are becoming harder to reach and are refusing to participate in surveys even when they can be reached (LIOR, 2012). Farmers specifically are even harder to reach (PENNINGS et al., 2002) and some authors have recently noted that farmers tend to prefer sharing information on a more practical and personal level (FRANZ et al., 2010).

Figure 23 - Survey response rate per language



Source: developed by the author (2022).

As explained in the methodology chapter, the web survey was one of the suitable methods for carrying on the research, particularly in a difficult period where this research was developed. The global pandemic of the COVID-19 limited the research activities, and the data obtained from this survey accomplished its methodological intent, reaching a reasonable number of farmers.

4.4.2. The limitations of this survey

It is important to mention this survey limitations. That it's important to any scientist to analyze the methods used acknowledging its strength and limitations, in order to enhance the researcher experience for future projects and evolve as a scientist.

In terms of sampling, this survey could miss participants from different social media platform or participants that joined the working group after the survey was closed, or even that some work group was not identified. Also, before sending the survey to the participants, it was circulated with peers asking for suggestions and alterations which were crucial to improve it. Nevertheless, when analyzing and discussing the survey data, It was noted that some piece of information could have added interesting points to discussion. For example, information regarding nationality, age and gender. According to Evans and Manthur (2005), any survey will have limitations, which should be identified by the authors, so the strengths of it could be placed in a more comprehensive manner when discussing the data.

On the other hand, the open-ended questions, provided many insights beyond the expect. According to Braun and colleagues (2021), by allowing participants to both, select and type responses using their own words can generate rich and complex accounts of the sense-making from which qualitative researchers tend to be most interested - such as participants' subjective experiences, narratives, practices, positionings, and discourses. Many questions of this survey were structured in this way, and the results of this insightful answers were presented in the sections below.

4.4.3. Farmers' experience in using DHDs – indications of a useful agricultural technique

Overall, it was possible to see that around half of the respondents have been using DHDs for more than ten years (49%). Such a long period of using DHDs could be an indicator of the usefulness of DHDs in agriculture, mainly when we are correlating this information with another piece of data from this survey, where farmers said they get good benefits from using DHDs in agriculture. The reason for that being farmers only tend to adopt techniques if they experience positive impact on their farming management (STAAL et al., 2002). Frater et al (2013) corroborates that position arguing that farmers

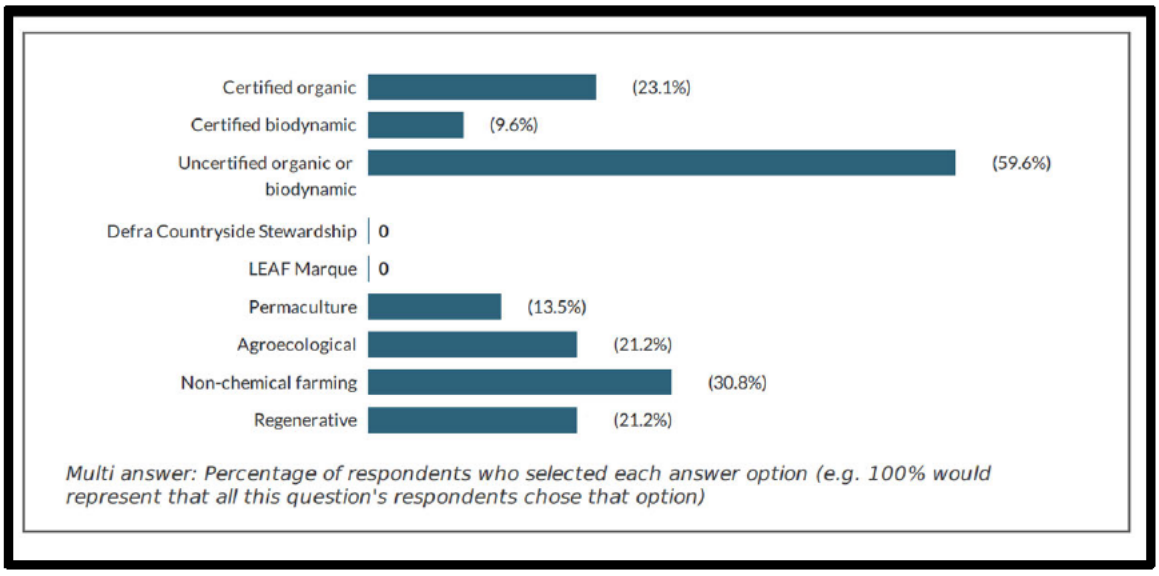
tend to keep using any tool/technique for longer periods if they perceive the benefits of such tools in the long run.

Interestingly around 29 % of the respondents just recently (0 – 3 years) started to use DHDs. In addition, around 22% of the respondents have been using DHDs between 4 to 10 years. This scenario reflects a growth in interest for the so called subtle agroecological methods (WRIGHT et al., 2021). The use of dynamized high dilutions in agriculture is still an outlier amongst sustainable farming methods. Even so, the number of research studies, as well as the number of farmers who utilize them, has increased significantly in the last decade (TURINEK et al., 2009; PEREIRA et al.,2019).

4.4.4. Farming profile and Self-identity: what kind of farming method is using DHDs?

The figure 25 displays how farmers self-identify regarding their farming profile. The participants could select up to three options they agreed best described their farming profile.

Figure 24 – Farming profile and self-identity



Source: developed by the author (2022).

Around 60 % self-identify as uncertified organic or biodynamic farmers, while 23% declared to be certified organic and 10% were certified biodynamic. As the certified biodynamic farmers could also be certified organic (because, at least in the UK, BDCert

provides biodynamic certification as a top-up to organic), this means that between 8-20% of respondents did not identify as either certified or uncertified organic or biodynamic farmer.

In addition, agroecological (21%), non-chemical (30%) and/or regenerative (21%) altogether make them 72% of the. Interestingly, even with the survey circulated in UK based web-communities there were no Defra and LEAF marque selected by any of the respondents. This suggests that farmers perceive porous boundaries between different sustainable farming approaches but a less porous one with LEAF and Defra certification standards.

There are some possible explanations for that. Some studies have shown that the costs for farmers to keep a certification stamp are invariably high, mainly the ones who are certified via private control bodies/companies (ZORN et al., 2012). Though, in some cases, certification companies lower their charges in order to be competitive, but at the same time, the scrutiny of the control may be compromised, therefore impacting the quality and farmer's reputation (RUNDGREN, 2009). As a result, some farmers tend to sell their products locally, without certification stamps, relying on their standing reputation amongst the community or choosing participative certification methods (LEITÃO et al.,2019).

There is also one more valuable piece of information from this section, and that is the actual fact that high-dynamized dilutions have being used by different farming types. This piece of information supports the other research data who corroborated the success of homeopathic preparation in conventional, organic, biodynamic, and permaculture systems (MORENO, 2017).

This information lead to the next question, where do the participants get technical advice on using DHDs from?

4.4.5. Sources of technical advice when using DHDs

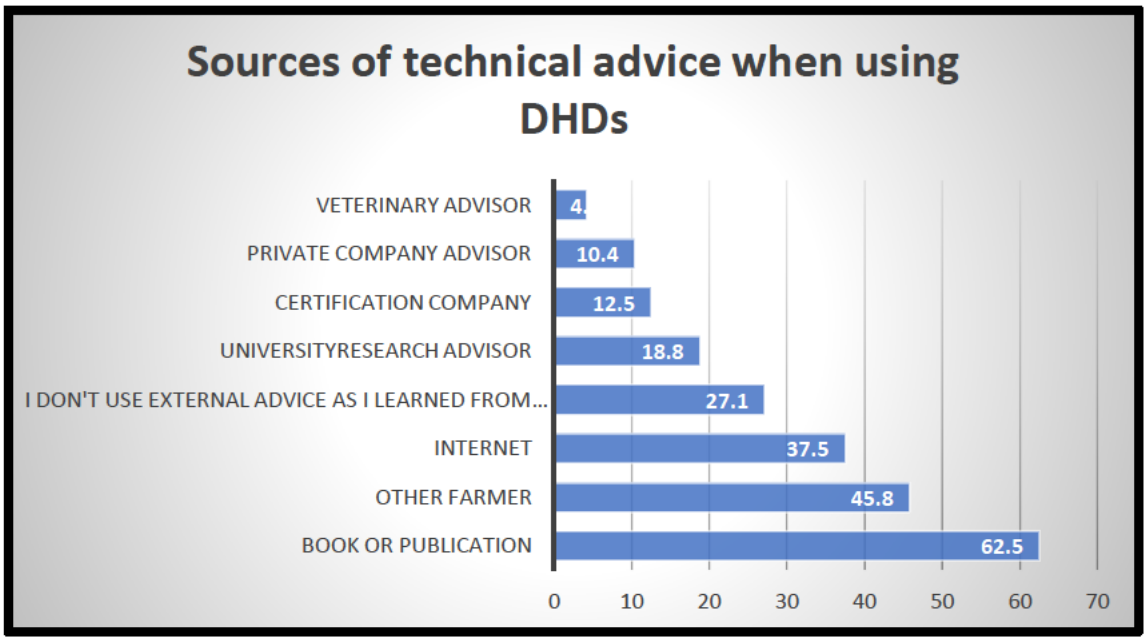
The figure 26 display data regarding technical advice when using DHDs. About 12% of the respondents get their technical advice from certification companies. Similarly, 10% said that they get technical advice from private companies. This information cross-correlates with the low certification profile identified in the previous section. A slightly higher percentage of about 18% of them said that they get their advice from a research

advisor/university. This could be eighter because there are few researchers investigating the subject or because the farmers prefer their advice with other peers. It seems that both options are right.

About 46% of the respondents said that they seek advice directly from other farmers, and even with internet (37%), books are still the most popular source/choice with 62% of advice. This data could illustrate that farmers tend to rely on their peer's experience and on their own insights obtained through their own investigation and practice.

It seems like this assumption is shared by other authors. Nancy et al (2010) in their paper on how farmers learn, explain that farmers tend to rely on first-hand experiences – either reading or practicing- having as motivation time and money-saving, preferring to engage the social aspects of farming education, enjoying peer teaching; farmers desire more comprehensive education (that's way books would still be chosen); farmers find value in participatory research/farming practices - rather than being an exclusively selling end.

Figure 25 – Farmers technical advice to use DHDs



Source: developed by the author (2022). Multi answer: percentage of respondents who selected each answer question (e.g., 100% would represent that all this question's respondents chose that option).

Quite curious is the fact that for 27.1% of respondents said that they do not use external advice because they learn from tradition/upbringing. Also, it is worth mentioning

that a minority of 4.2% seek veterinarians for technical advice, even though the use of homeopathic preparations for veterinarian purposes is one of the most common uses, even more than in plants (PAIM et al., 2020). This may be also a reflection that conventional vets do not deal with homeopathy.

Such autonomy in looking for knowledge and advice by farmers who utilize DHDs receives criticism by some authors who claim that the lack of rigid technical support and information places the method as being based on high levels of empiricism, therefore being not reliable as farming method (MULLET, 2018). On the other hand, farmer's capacity to develop their own farming skills regardless of external advice is also seeing as a vehicle for independence and an important factor to overcome some of the problems of the Green Revolution package (PIMBERT, 2015; TIMMERMANN and FÉLIX, 2015).

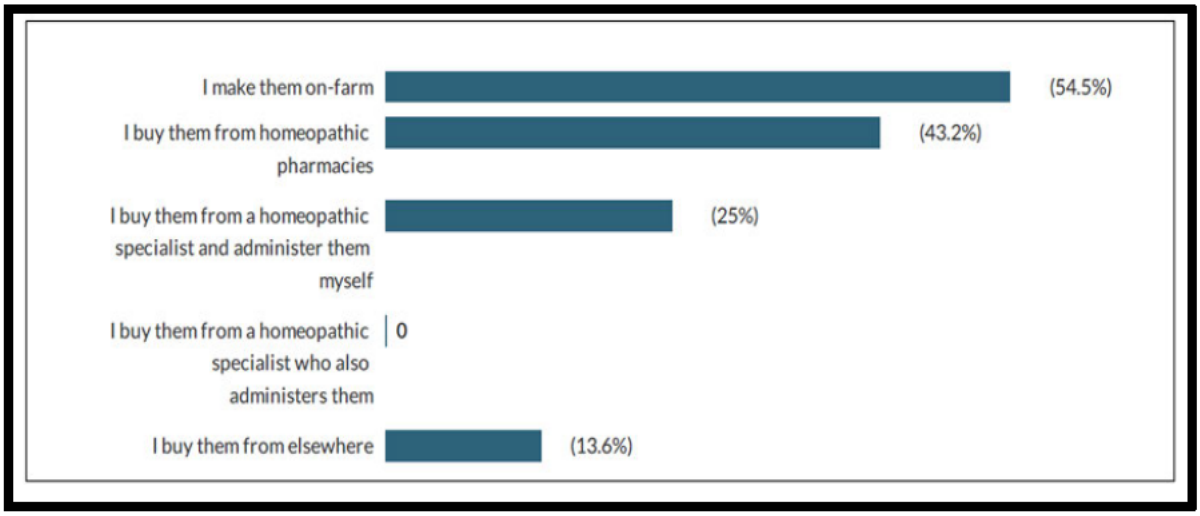
These results also indicate the necessity to share knowledge in ways that are more aligned to farmers' interests. For the DHDs to have a greater impact in agriculture, besides focusing exclusively on the publications in scientific journals, other forms of knowledge-sharing should be used, e.g., elaborating a short video of research to be available on the internet; or writing a book (including out of this thesis) focusing on the use of DHDs in agriculture.

Having identified their source of advice, it was time to ask an associated question. Where do farmers source their DHDs from and which ones they are using?

4.4.6. Where do farmers source their DHDs from and which ones they are using?

Figure 27 display information regarding where the farmers source their DHDs from and which ones they are using. Most of the respondents said that they either make them on the farm (54%) or buy them directly from homeopathic pharmacies and internet (43%). It was interesting to notice that no specialist on the subject was required to come and apply them. This could be either by the lack of advisors in the area or no interest by the farmers in having one. This piece of information correlates with the source of advice information (section above), enhancing even more autonomous profile of the farmers who use high-dynamized dilutions. The fact that for 25% of the participants buy from a homeopathic specialist and administer them by them self's, strengthen that profile.

Figure 26 - Source of the DHDs



Source: developed by the author (2022). Multi answer: percentage of respondents who selected each answer question (e.g., 100% would represent that all this question's respondents chose that option).

When asked specifically about what the most used homeopathic preparations were, around of 40 different homeopathic preparations were named, using the potencies 6CH,12CH, 30CH and 200CH. It was satisfactory to know that most of the HDDs that were used in the strawberry trials in this research, except for *Mercurius solubilis 12CH,* were present in the farmers list. The table 18 present the most common homeopathic preparation used in agriculture by the web-survey respondents.

Table 18 – List of the most common homeopathic preparation used by farmers

Homeopathic preparation	**Potency CH = Centesimal Hahnemannian**
Arnica Montana	6CH;12CH;30CH;200CH
Arsenicun albun	30CH
Aconitun napelus	6CH; 30CH
Apis melifera	6CH;12CH;30CH
Belladona	6CH;10CH;12CH;30CH;200CH
Bryonia	6CH;10CH;30CH
China officinalis	12CH, 30CH
Carbo vegetabilis	6CH;12CH;30CH
Colocynthis	12CH
Caulophyllum	30CH
Calcaria phosphorica	6CH;30CH
Calcarea carbonica	6CH;12CH;30CH;200CH
Calendula officinarun	12CH;30CH

Ferrum metalicun	10CH; 30CH
Ferrum sulphuricum	6CH;10CH;30CH
Ferrum phosphoricum	6CH;30CH;60CH
Gelsemium	30CH
Hypericum	12CH
Hepar sulphur	30CH;200CH
Helix tosta	6CH;12CH
Ignatia	10CH;12CH;30CH;200CH
Kali carbonicun	6CH;12CH;30CH
Kali phosporica	10CH;30CH
Magnesia phosphorica	6CH;10CH
Naturum sulphuricum	6CH
Naturum muriaticum	6CH;10CH;30CH
Nux vomica	12CH;30CH
*Nosodes**	6CH;10CH;12CH;30CH;100CH
Pulsatilla	30CH
Phosphorus	6CH;10CH;12CH;30CH;60CH;200CH
Psorinum	30CH
Pyrogenium	12CH
Ruta	12CH
Silicea terra	6CH;12Ch
Sulphur	6CH;10CH;12CH;30CH;200CH
Staphysagria	12CH;30CH
Salsaparrilha	7CH;12CH
Urtica urens	12CH
Viburnum	10CH

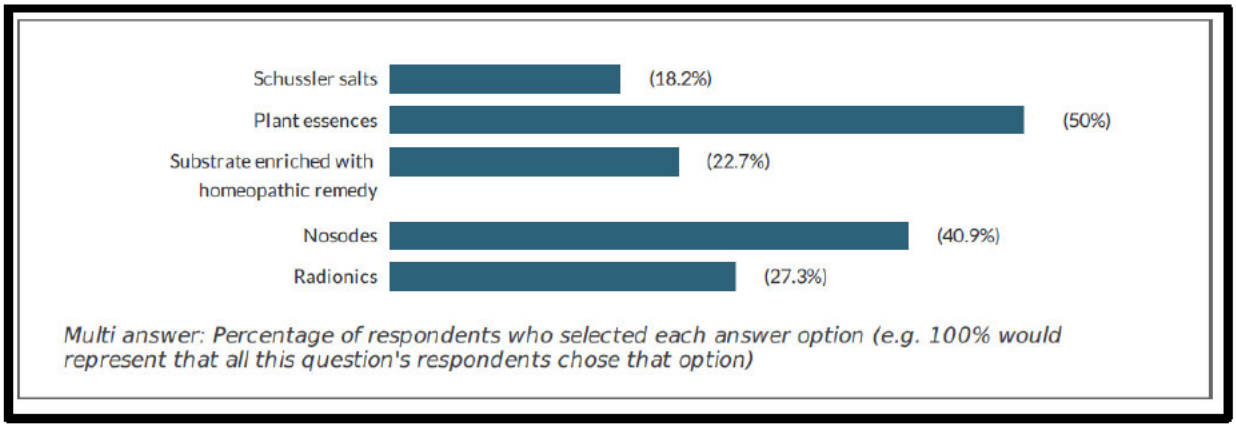
Source: * Nosodes made of soil, plants. developed by the author (2022).

As seen in the list above and in the figure 27, Nosodes were present and used by 40% of the respondents. Nosodes are homeopathic preparations that are not included in the *Materia Medica* but have in their core the pharmaco-technique of making a homeopathic preparation (mother tincture + dilution + dynamization). Usually, they are made of the main problem that they want to solve e.g., Nosode of leaf-cutting ant is made from the ant to control ant's foraging (GIESEl et al02017); or to treat the leafspot in tomatoes, a Nosode is made of the leaf having the spots (MODOLON et al.,2012).

Other methods mentioned (figure 28) were, the use of plant essences (50%), radionics (27%), Schussler salts (18%). In addition, when asked specifically about the biodynamic preparations (figure 30), the respondents, informed that the high-dynamized dilutions of P500 (89%) and P501 (81%) were the most used. The remaining BD preparations accounted for around 70% of usage. When correlating data from figure 29,

we see that substrate enriched with a homeopathic preparation (22%) - which is a very similar approach to the biodynamic compost preparations - suggest that users are trying different combination of techniques based on their empirical results.

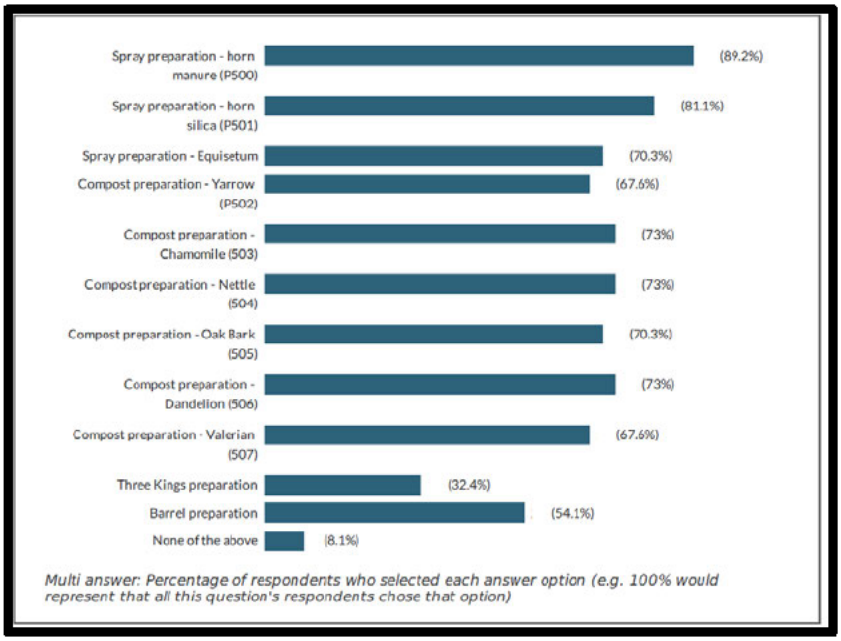
Figure 27 - Subtle agroecological approaches used by respondents



Source: developed by the author (2022).

Also, this information strengthens the close connections between homeopathy used in agriculture and biodynamic farming as sources of methodological reference to each other and that farmer who use dynamized high dilutions are familiar with the biodynamic approach and agrohomeopathy and vice versa.

Figure 28 - biodynamic preparations used by DHS users

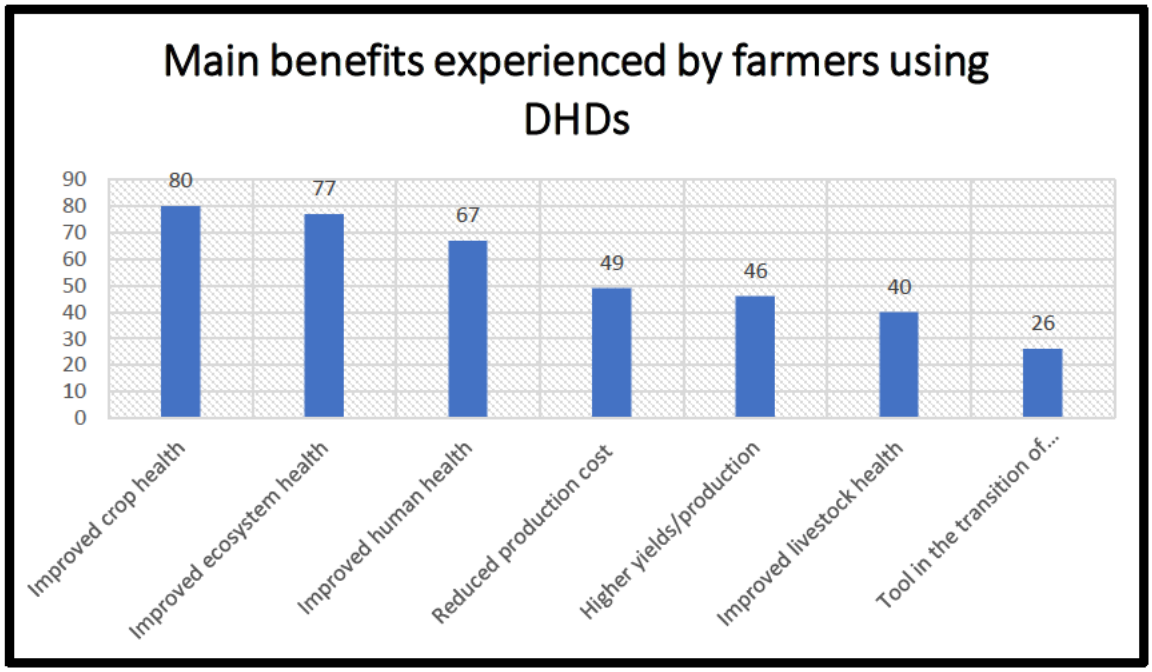


Source: developed by the author (2022).

4.4.7. Main benefits experienced by farmers when using Homeopathy and DHDs in agriculture

The figures 30 and 31 display paramount information of this survey. Respondents were asked about the mains benefits experienced and reasons for using homeopathy in agriculture. To start with the main benefits experienced, they were able to tick all options that they strongly agreed with (multi answer question). Overall, 80% acknowledged improvements in their crop health; 77% confirmed an improvement in the ecosystem health; 67% affirmed that human health was improved. Interestingly, 49 % of them stated that high-dynamized dilutions reduced their production costs, with 46% of them reporting for higher yields and 40% informed improvements of livestock health. Finally, 26.5% said that Homeopathy was used as management tool for transition of cultivation systems.

Figure 29 – Main benefits experienced and reported by farmers using homeopathy (DHSs) in agriculture



Source: developed by the author (2022). Multi answer: percentage of respondents who selected each answer question (e.g., 100% would represent that all this question's respondents chose that option).

These benefits may explain why most of these farmers are using dynamized high dilutions for more than 10 years. Usually, they tend to keep using or developing methods that are aligned with their set of morals, economic profits, and land improvement over

time (ALTIERI et al., 2017). In other words, they must experience clear benefits for their livelihood.

The sense of human health improvement is something that homeopathy and biodynamic farming share, firstly because both have a connection to human therapy (JOHNS et al., 2013; LEWIS and CASSELLS, 2014), and secondly, by being agroecological methods, they support production of high-quality food, free of pesticides, improving the value of food's nutritive properties, taste and human health and well-being (GOMIERO, 2018; BROCK et al.,2019). Still, some authors recommend that more research should be made in order affirm clearly that agroecological methods could produce better food than conventional systems (LEVIDOW, 2015).

From an agronomical perspective, the fact that the respondents stated that Homeopathy helped to reduce their production costs, served as a management tool for transition of cultivation systems, increasing yields and improved the livestock health, is very important. It's valuable piece of information because it bonds the farmers experience in the field, to the data from many authors that have being studying and supporting the potential uses of homeopathy and other DHDs in agriculture (BONATO and ANDRADE, 2011; JÄGER et al., 2015; ÜKER et al., 2018; BOFF et al., 2021).

In a final analysis, as homeopathy is a holistic method, the observed results should ideally somehow reflect that holistic effect. Therefore, the positive features experienced by farmers on different levels could be seen as a direct consequence of the improvements on the crop health and ecosystem, evidencing such holistic effect of homeopathy in agriculture. The fact that some farmers use DHD also because of spiritual influences evidence that the holistic nature of homeopathy and biodynamic farming permeates the most intimate reflections of man-nature-universe connections. The cascade benefits experienced, from the human to the agroecosystem health illuminate again this holistic nature.

4.4.8. Main reasons for using DHDs

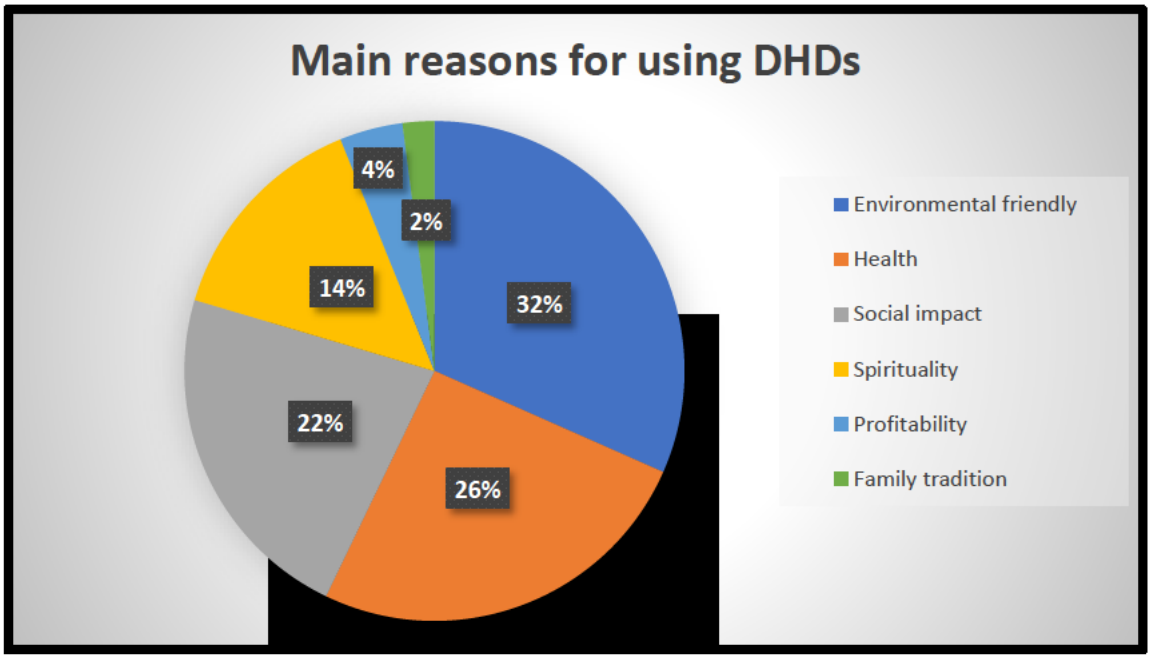
The respondents selected their reasons for using DHDs (figure 31): Accordingly, their main reasons for using dynamized high dilutions are because are environmentally friendly (32%), they present potential benefits over human health (26%), that the use of this methods may have positive social impact (22.9%), and that to a certain point it was

related to their own spirituality (14.6%). Completing it, profitability (4.2%) and family tradition (2.1%) were ranked last.

The questions regarding the main reasons for using DHDs in reality speak about these farmers motivation to do so. This is crucial to understand their worldview and to comprehend the reasons that inspired them. By their reasons, it's possible to grasp understanding on how they experience the phenomena and how they translate that world view through their farming approach and more specifically, the method they chose to use, in this case, homeopathy in agriculture.

With that been said and considering their answers, it is possible to assume that these farmers have a highly environmental orientation, probably perceiving a connection between their own health as consequence or linked to the healthy environment. In addition, they might presume that concern about environmental and health benefits would eventually impact society towards that environmental awareness.

Figure 30 – The main reasons farmers reported for being using DHDs



Source: developed by the author (2022).

Furthermore, the environmental, health and social reasons could be rooted in their spiritual orientation. Now, spirituality and religion although with similar connotations are in fact different. Religion deals with dogma whereas spirituality deals with consciousness and awareness. Chu (2007) defines spiritual awareness or spiritual capital as the simultaneous recognition of love, guidance and intuition, creativity, higher personality

traits and cultivated skills and knowledge (CHU, 2007). Most of the Chu's definition were verified in the previous sections of this chapter as being part of the DHD farmer's profile.

Interestingly, Kaufman and Mock (2014) discussing on the connection between spirituality and farming systems, argues that what they called Eco-spirituality or Eco-consciousness - combination of ecological and spiritual features - arise when farmers distinguish their land not as mere mean of profit, but rather as a mean to achieve a greater well-being having a direct impact on farmers health, economic and community benefits. In addition, Chen (2009), verified that organic farmers and organic food consumers are more environmentally conscious, and that consciousness leads to shift in their dietary and consumption habits. That led to a deep reflection on the importance of spirituality plays in agricultural practices.

According to Lewis and Cassels (2014), farming systems that consider the spiritual aspect on their management ground their interpretation of spirituality around issues of ethics, morals, values, and worldview, combining spiritual values with farming practices, stimulating the elaboration of social, cultural and symbolic capital. Those set of capitals means the valorization the local knowledge, skills, expertise, and experiences embedded in an individual perception, and interpersonal relationships based on mutual acquaintance and recognition, dialogue and trust. Once more, these features were also present in the DHD farmer profile as the survey identified it.

These forms of capital will eventually turn into symbolic capital (Bourdieu, 1999), enhancing the legitimacy of transformative actions, based on reputation and credibility of those actions.

Correlating the answers of reasons and benefits on using Homeopathy and dynamized high dilutions in agriculture, the research comprehend that the farmers focus on high quality food production, foreseeing to work in intimate partnership with nature and emphasized by an ecological, ethical, and spiritual approach to agriculture and food production. It is not just a method of growing, but a way of being, of living, and of making meaning.

4.4.9. How farmers experience vitality promoted by Homeopathy and dynamized high dilutions in agriculture

The respondents were asked how they are perceiving the influence of the HDDs regarding the promotion of vitality in the agroecosystem. The main relationship between Homeopathy and DHDs and vitality stated by the respondents are presented in the world cloud and the quotes below it. Overall, biodiversity; strength of life expressions; observation and gut feeling; happiness; health; healthy crops; taste of the products; stronger colours; wildlife diversity; pollinators diversity were the most cited definitions.

In addition, the participants quote provide insightful descriptions:

"*I see vitality in the site in the tolerance of plants to environmental stresses increasingly frequently"* (724895-724886-74677468).

"*Lack of disease and pest pressure*" (724895-724886-74678134).

"*Biodiversity. Strength of life expressions. Endurance*" (724895-724886-74679798).

"*Interrelationships become more active and visible, the atmosphere around is more subtle, human relationships are transformed, the presence of wild animals is more evident, the soil changes color, appearance, humidity level, consumers are more interested in production and want to get involved, etc.*" (724895-724886-74687015).

"*When I observe a balance between all the spheres that surround it, such as: social, environmental; economic. Making it develop with health*" (724846-724837-74706137).

"*Taste of fruits and vegetables, health of the soil and plants*" (724895-724886-74751228)

"*Enhancement on observation and gut feeling – reading better the dynamic on the farm*" (724895-724886-74771339)

"*It's the force that moves matter*" (724895-724886-74809243)

"*Health of animals, plants and people. Fecundity if all living beings on the farm. Lack of diseases. Happiness*." (724895-724886-74870202)

"*We are regenerating very degraded land. We are watching it slowly but surely improve*" (724895-724886-74809243)

So, rather than a single or global definition, the survey revealed that vitality could only be grasped throughout its many sociological and biological facets of perception. This information is important because under a phenomenological inquiry, understanding the experience of a lived phenomenon (SULTAN, 2018), helps to build structure in terms of education, providing possibilities for articulating theories of teaching and learning in

close relation with concrete practice (BRINKMANN and FRIESEN, 2018). In this case sourcing methods for the reformation of agriculture towards sustainability.

Furthermore, the survey reflected on the importance of Homeopathy on offering a genuinely holistic approach to agriculture. The method showed relevant to help on the dialogue and comparison between salutogenic arguments vs the industrial ones in agriculture (table 19), and ultimately influence farming practices and research towards autonomy and social justice. Therefore, the contrasting approaches to deal with agriculture will eventually guide human interaction with the agroecosystem and finally its destiny.

Table 19 - Contrasting approaches in agriculture

Criteria	Thesis	Antithesis
Values	Naturalist: be objective	Normativist: apply values
Discipline	Chemical: use molecules	Ecological: employ ecological interactions
Focus	Negative: kill the pathogen	Positive: Strengthen the plant
Method	Reductionist: find rules	Holist: Integrate
Interference	Functional: deliver	Resilient: be self-sufficient
Nature	Materialist: find the mechanism	Vitalist: feel the force
Ethics	Anthropocentric: fill the basket	Biocentric: Support the plant
Definition	Definitive: be concise	Fuzzy: embrace complexity
Change	Conventional: maintain the *status quo*	Alternative: promote the change
Mindset	Industrial: maximize production	Traditional: maintain multiple benefits

Source: developed by the author (2022), adapted from Antonovisky, 1996; Döring et al, 2012.

The limitations of the industrial agriculture and its dependence on external inputs sets a contrasting scenario when comparing it with the farming profile identified in this study. With the ongoing Russia-Ukraine war (2022), the fertilizer shortages created insecurity in food production worldwide. This critical scenario is exactly the one that agroecological authors have been pointing out in the last decades (ALTIERI et al., 2014; GLISSMAN, 2014; PIMBERT et al., 2015).

In addition, a constant concern on observing the nature manifestation as a mean to best interact with it was present on this farmers statements, and evidenced in the details describing vitality perception in response of the homeopathic preparations:

> "*It is a constant process of finding the right components, timings and methods. One must always be there with the full awareness to interact with nature* (824895-724886-74809243)*"*.

This study could infer that this highly observative attitude is fundamental to evolve and develop any method, being crucial for generating new forms of knowledge, so needed to change the current agriculture paradigm. Immanuel Kant (1724–1804) introduces the theoretical and practical parts of his philosophical system, explaining that human understanding is the source of the general laws of nature that structure all our experience is based on one's own experience, and that the human reason gives itself the moral law, which is our basis for freedom. Therefore, it could be acknowledged that Homeopathy and the use of dynamized high dilutions are contributing to evolution of scientific knowledge, structuring a worldview that is holistic and not limited by Cartesian worldview, stimulating free thinking because it valorises one's experience in the development of the subject as well as connecting different perspectives.

In general terms, the DHDs are not widely used in agriculture, and it still is an outlier, suffering resistance even inside the agroecological research sphere. Regardless this scenario, the fact that the respondents affirmed to be using DHDs for decades, not relying on stamps to classify their farming, seeking for technical advice in books and peer-exchanges that allows them to make their own decisions is an indicator of that reflects an independent alternative mindset.

Such independent thought should be stimulated because it configures as tool to question the *status quo* - no matter if governmental or scientific – or as posed by Wanderley (2009), independent thought in agriculture is a way to fight against the indirect domination of capital in agriculture, helping farmers to build the rural space as one of life. In this sense, exploring the use of Homeopathy in agriculture and the dynamized high dilutions would be a way of cultivating the independent farming thought…and independent thought is crucial for framing the ontological changes needed in agriculture because they break the chains of the mainstream agricultural approach.

4.5. CONCLUSION

Overall, the data survey farmers who completed the survey could be described as: a) experienced in the use of the technic (49% are using it for more than 10 years); identify themselves as independents, not relaying on certification stamps (60%) but rather in their farming profile, mainly described (72%) as non-chemical, agroecological, regenerative organic and permacultural; b) autonomous and pragmatic when seeking for technical advice, preferring books (62%) and peer-exchanges (45%); c) The HDDs used in this study's controlled experiments are commonly used by these farmers; d) that HDDs user perceived improvements on crop (80%), livestock (40%), ecosystem (77%) and human health (67%). In addition, they reported reduction on their production costs (49%), higher yields (46%); e) that their main reasons for using high-dynamized dilutions is because that are an environmentally friendly (32%), with impacts in their health (26%) and potential benefits for society (22%). Furthermore, 14% of the respondents stated spiritual reasons for using them; f) Farmers experience and perception of vitality is a very personal, subjective but still pragmatic way with consequences to ontological perspectives towards the man-nature relationship.

5. THE USE OF HOMEOPATHY AND DYMATIZED HIGH DILUTIONS TO PROMOTE AGRICULTURE VITALITY: ADDRESSING CHALLENGES AND IDENTIFYING SOLUTIONS

5.1. ABSTRACT

Homeopathy and dynamized high dilutions have been investigated in agriculture since early 1926 and the number of papers on the subject increased drastically in recent years. However, methodological challenges are seen as limitations to expand the use of the method on research and farming practices. The objective of this study is to address the main challenges identified in the use of Homeopathy and dynamized high dilutions in agriculture as well as to delve into the nuances of vitality perception. To answer those issues, interviews with an international group of key stakeholders with expertise in homeopathy and DHDs in agriculture were carried out. Thirteen interviews with participants from 7 different countries were conducted. The interviewees were researchers, farmers, and advisors. The data from interviews were analyzed using the software NVivo®. The interviews allowed an in-depth comprehension of those difficulties as well as to cluster pragmatic information on how to deal with them. As a result, methods to select DHDs and potencies, mode of application and volumes are presented. In addition, the phenomenological knowledge necessary to make sense of that data is analyzed. The interviews exposed how different professional backgrounds can benefit from learning and using homeopathy. In addition, the practical information on the uses of homeopathy and high-dynamized dilutions in agriculture laid the foundations for further procedures to be used in research and in the field. Finally, the discussion on vitality revealed that it inspires revisiting the culture of agricultural development and the primordial values and interactions of humans, putting together as outcomes the ecological, social-economic, philosophical, and spiritual benefits. Not in a hierarchical way but rather as one interdependent to the other. Such a holistic approach can ultimately help humanity to evolve towards an integral life, helping humankind to restore its connection and respect to nature.

KEYWORDS: Ultra high dilutions; Vitality; Research and Farming; Interviews

5.2. INTRODUCTION

Stepping further in the investigation on the uses of homeopathy and DHDs in agriculture and vitality perception, this chapter complements the findings from the systematic review, web survey, and experiment.

5.2.1. Addressing challenges on the use of Homeopathy and dynamized high dilutions

Homeopathy is grounded in non-conventional assumptions (TEIXEIRA et al., 2017). However, advances in areas such as biology, physics, and others have brought a new kind of understanding of nature, and as consequence, the arise of non-conventional concepts and assumptions trying to understand nature manifestation (SHALDRAKE, 2009). Therefore, many of the homeopathic philosophical and methodological assumptions such as the resonance principles, the use of dynamized high dilutions and the effect of them over the organism vitality are seen with new interest (WAISSE and BONAMIN, 2016).

Even though studies with DHDs in plants have been investigated since early 1926 (KOLISKO and KOLISKO) and the number of papers on the subject increasing drastically (JÄGER et al., 2015; BAUMGARTNER et al., 2018), there is a lack of information addressing methodological and practical difficulties on using it (CLAUSSEN et al., 2014). Therefore, studies focusing these difficulties and clustering information on how these challenges were addressed are needed in order to improve its use on research and in the field.

One way to acquire in-depth knowledge about a subject is to relate the issue to personal experiences and reports, by doing interviews with key-information sources (PATTON, 2014). This is particularly useful when trying to understand how people with different realities solved similar problems and situations (OPDENAKKER, 2006).

The objective of this study is to address and propose solutions to the main challenges identified in the use of Homeopathy and dynamized high dilutions and the perception of vitality in agriculture to help answer the question “Could a deeper understating of Homeopathy and vitality in the agroecosystem help to improve farming and research strategies?” Therefore, based on methodological and empirical results from

interviews done international group of researchers, advisors, and farmers with expertise in the use of homeopathy and DHDs in agriculture, some conclusions are presented next.

5.3. METHODOLOGY

Interviews are defined as qualitative research methods whose purpose is to gather descriptions of the lifeworld of the interviewee with respect to interpretation of the meaning of a described phenomenon (OPDENAKKER, 2006; PATTON 2014).

5.3.1. The interview approach in this research

In this research, the interviews were undertaken with a focused information source, following a semi-structured framework, to provide the opportunity to clarify any outstanding issues, and obtain insights of the respondents (BABBIE, 2004). This method has the potential to help highlight the roles and relationships between different actors, what they actually did, how they learnt, and how they shared ideas and experiences (PATTON, 2014). The data from interviews allows to characterize a personal world view and work experience, understanding how the interviewees experience the phenomena (CRESWELL, 2015).

In this study, the interviews addressed the main challenges identified in the literature review and the survey, regarding the use of Homeopathy and dynamized high dilutions and the vitality perception. For instance, the DHD selection and potency, repertorization and anamnesis, protocol and mode of application of dynamized high dilutions and finally, how vitality is perceived and what are the impacts on perceiving it to farming and research practices. All these parameters were identified as limitations on applying and using dynamized high dilutions in a more efficient way. The semi-structured interview facilitated data collection as well as sourcing space for distinctive insights, hence, obtaining quali-quantitative information.

The interviews were done online due to the COVID-19 restrictions, using platform Zoom®. The interviews were recorded with the participants authorization and its content was checked for ethical approve, following confidentiality, anonymously and security features. The interviews last from 1 to 1.5 hours (see appendix C for the semi structured questions used in the interviews).

The interviewees were chosen via opportunistic selection - This occurs when researchers make sampling decisions during the data collection process. In the process of gaining more knowledge about a situation, the observer can make sampling decisions that are informed by the unfolding events (PATTON, 2014).

Some interviewees were selected from the literature; others via projects that work with agrohomeopathy through their official company websites; from contact in conferences like the Biodynamic Conference (Dörnach, February 2020), the Oxford Real Farming Conference and the Biodynamic Conference (2021); Finally, some were selected via the web-survey. The invitation to participate in the interview were done by email. The list of interviewees is shown on table 20. Overall, 13 interviews were done, and the interviewees were coded to keep anonymity.

Table 20 – list of interviewees

Key information sources	Country	Interviewee code
Advisor **Agronomist Homeopath; GT Saúde ABA (Brazilian Association of Agroecology)**	Brazil	Advisor A1
Advisor **Homeopathic Pharmacist and Agriculture Advisor**	United Kingdom	Advisor A2
Advisor **Agronomist Homeopath Homeopatia Rural**	Brazil	Advisor A3
Advisor **Homeopath and author for homeopathy in plants**	*Germany*	*Advisor* A4
Advisor **Agrohomeopathy institute**	Italy	*Advisor* A5
Researcher **Vetrinarian** **Universidade Federal de Viçosa**	Brazil	Researcher R1
Researcher Agronomist Forschungsring,	Germany	Researcher R2

Researcher, Agronomist Forschungsring	Germany	Researcher R3
Researcher The Organic Research Centre	Germany	Researcher R4
Farmer Biodynamic Preparation master. Biodynamic Association	India/United Kingdom	Farmer F1
Farmer Apricot Centre – Huxhams Cross Farm and Wellbeing Service for Children and Families	United Kingdom	Farmer F2
Farmer and author in Agrohomeopatía: homeopatia para las plantas en agricultura e jardins	Spain	Farmer/Advisor F3
Biodynamic Association	United States/Australia	Farmer/Advisor F4

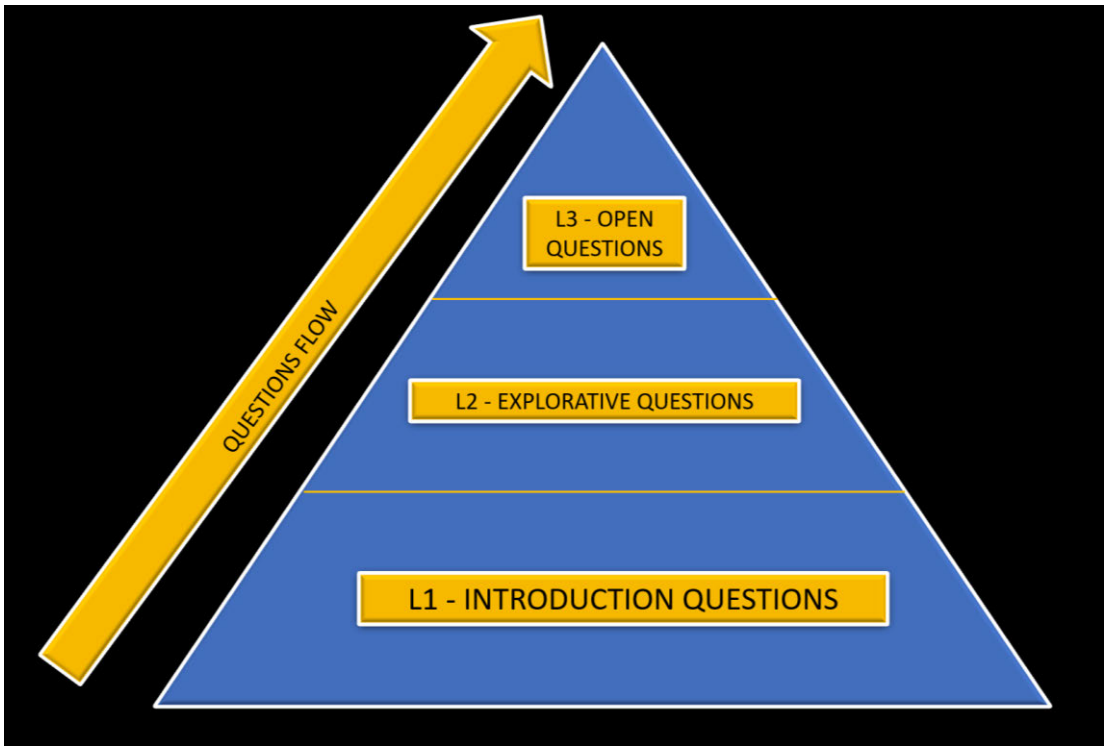
Source: developed by the author (2022).

Before conducting the interviews, the questions were piloted amongst peer researchers who helped to clarify the questions to avoid confusion as well as adding specific ones aiming to extract most in depth information from each of the interview categories. It was also tested in terms of time.

Taking into consideration which language the interviewees felt more comfortable with sharing their information, the interviews were conducted either in English, Portuguese or Spanish. The information was categorized and organized with the help of the software Nvivo©12 Plus qualitative data analysis.

Before the interview started, a rapport was established mainly focusing on a briefly introduction to the research objectives, global agriculture scenario, and the world pandemic situation. The rapport was an effective start to "break the ice". The interview script followed - question pyramid flow (broad to specific) approach (figure 34), where first questions were designed to grasp backgrounds and professional inspiration and experience (L1–introduction questions). Next, questions were focused on specificities from homeopathy use in agriculture and vitality (L2-explorative questions) and finally, open questions that appeared due to the interview content and environment (L3 –Co-created questions).

Figure 31 – Semi structured question flow.



Source: adapted from Patton (2014). developed by the author (2022).

5.4. RESULTS AND DISCUSSION

5.4.1. Challenges and solutions on the use of DHDs and Homeopathy in agriculture

The preparation for the interviews were quite intense. It was made sure to have all the settings ready: paper for notes, interview script ready, internet connection checked and a mug of coffee, tea or chimarrão (a traditional south American tea).

The researcher was bit nervous for the first interviews, but as soon as they got more frequent, the researcher got more confident and comfortable with them. Also, the quality of the interviews in terms of how natural the interview happened also improved along the way. The first ones were a bit stiff, but after the researcher got familiar with the method, the interviews were pleasant and interesting, and by the interviewer perception the interviewees were also more engaged as the research got more details and information as the researcher also got used with the method.

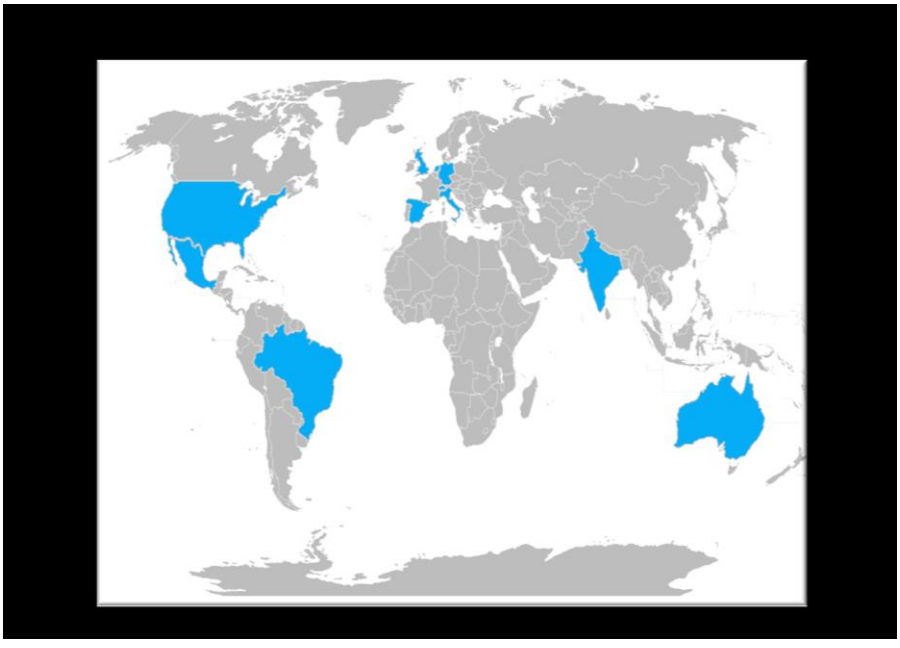
Also, if in one hand there was a missing feeling regarding the *in loco* experience and a physical interaction with the interviewees, on the other hand, the online interviews allowed me to reach an international perspective which added significant quality to the interviews.

5.4.2. An international perspective on the use of Homeopathy and dynamized high dilutions

Overall, 13 participants from nine countries were interviewed (see figure 35). The participants were from Australia, Brazil, Germany, India, Italy, Spain, United Kingdom, United States and Mexico.

From the 13 interviewees, six were females and seven males, composing a group of 5 advisors, 4 researchers and 4 farmers. They were coded according to each category e.g advisor (A1), researcher (R1) and so on. The participants age ranged from 35 to 76 years old. All of them have been working with homeopathy or biodynamic farming for long periods, having a professional experience that ranged from 10 to 40 years.

Figure 32 - Interviewees geographical distribution



Source: developed by the author (2022).

5.4.3. The decision-making process - Why did you decide to work with homeopathy?

One of the first questions posed for the interviewees was regarding their decision to choose to work with homeopathy and DHDs in agriculture. Despite the different personal histories, nationalities, and work activities, they had been experiencing a common feature: a sense of failure and limitation to obtain relevant results in their activities.

Advisor A1 from the UK illustrates his scenario:

"*I started my career in the 1970's in a pharmacy in London. Working there gave me the experience to later decide to start work with homeopathy.*

I noticed that people who came to the pharmacy were regulars. Sadly, many of them did it by habit. Of course, there were those who depended on specific treatments, but generally speaking, those people were looking for health, vigour and vitality by taking all sorts of medicines. And the most painful part to me: no matter how many drugs they took, they simply kept returning. The use of those drugs was overlapping each other in so many ways that they were clearly stressed. So, there was no cure at all…There was no true healing. It was a vicious cycle, based on remediation". (A2/UK - 17/05/2020).

A similar scenario was highlighted by farmer F3 from Spain:

"*I first started to look for different methods to be used on my farm. At first, I was a conventional farmer. Even though I used modern products to kill the pests and, year after year added more fertilizer to the crops, somehow the farm was always under pressure and the system seemed to be collapsing. At least I was. That approach was not only expensive but also not efficient, not to mention the effects that I was observing on the life in the field.*

It was then when I heard about organic farming. One of my neighbors told me about subsides given by the EU government to expand the organic farming in the country. I came from a farmer's family and while studying organic methods I could relate to various techniques that were used by my grandfather many years ago. For example, the use of compost as source of nutrients for plants. Then, by coincidence, in an organic market in Barcelona, I came across a leaflet about homeopathy. The words 'vitality', 'harmonious' and 'long-lasting cure' hooked my attention. After searching on the internet, I discovered that people were using homeopathy in plants. I got interested because I felt that my land was ill after years of intoxication. I decided to give it a chance. I'm glad I did. (F3/Spain – 07/03/2021).

So, it was possible to see that the participants had an urge to use a method that would provide a dramatic turn in terms of long periods of non-intervention and that by

the same time potentially promoted health. For these people, homeopathy was the chosen method to deliver that.

5.4.4. Is it possible to different professional backgrounds to work and apply homeopathy in agriculture?

According to the participants, homeopathy has something that places it in very special place, and that is the integration of different knowledges under its methodological scope. However, there has to be an immersion and ideally training on it to proper use it.

According to the interviewees, homeopathy is a complex science and its philosophy is deep, its bibliography vast and its work-method not conventional. Therefore, qualification/training is needed in order to properly apply it. All interviewees have undergone training in homeopathy, that ranged from 6 months to 2 years, depending on the institution where they received the training and their professional background.

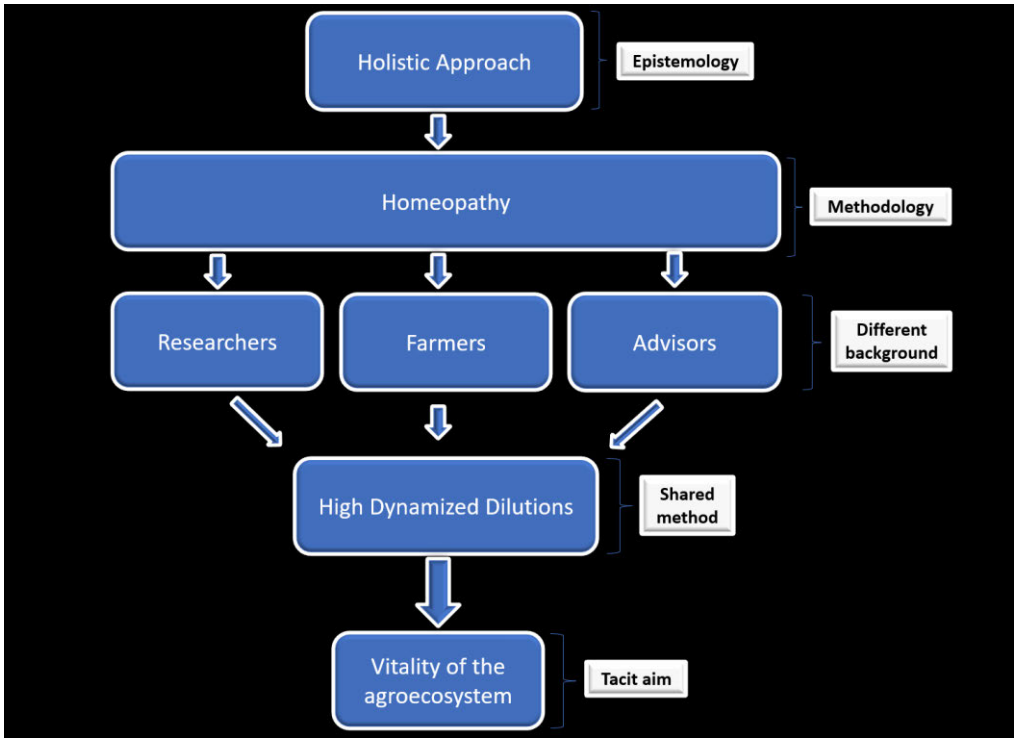
As the adviser A2/UK, who is a pharmacist and works now with agriculture states:

> *"The crucial thing is to understand and be familiar with its concepts, because it will allow you to relate better with the method, then you'll have the experience to link the distress situation under a homeopathic framework so to speak, and then apply it to solve the problem".* (*A1/UK - 17/05/2020*).

One common point was that stakeholders felt there was a lack of information about homeopathy. This point concurs with that of the survey participants who said that their main reason for not using homeopathy in earlier stages on their farming practices, was the lack of information about it.

When analysing the interviewees different backgrounds, it was possible to see that all of them had already a certain worldview that embraced a holistic approach, and that's why they moved into homeopathy. In addition, after getting training on homeopathy, they were able to navigate around different areas of knowledge, different from the ones where they first started. When they got experienced on using high-dynamized dilutions, they could also expand and solidify their holistic epistemology in a certain feedback loop. These deductions are illustrated in the figure 35, where a conceptual diagram is presented taking in consideration the interviewees information.

Figure 33 -Integrative homeopathy conceptual framework



Source: developed by the author (2022).

Homeopathy was originally created to be used for human therapy. However, Hahnemann himself wrote on its Organon of the art of healing, that homeopathy should be applied to all living beings (HAHNEMANN, Organon, paragraph 9, 1842). And that's how homeopathy started to be used in animals and plants. Moreover, I could verify that the homeopathy ontology is integrative rather than exclusivist, allowing its use by different backgrounds. For example, the interviewees ranged from agronomists, pharmacists, biologists, accountant, sociologists to farmers. All of them perused training in homeopathy afterwards in their carrier. It was possible also to evidence the potential transdisciplinary role of homeopathy.

According to Piaget (1970) there are three levels of collaboration and integration between disciplines:

• Multidisciplinary is the smallest level of integration. It appears as a problem-solving approach, when one searches for help in other disciplines, with no interaction or enriching the subjects, and no moving to levels of cooperation.

• Interdisciplinary is the level of association between disciplines, that implies cooperation between them, involves genuine connections, with mutual benefit and reciprocal development.

• Transdisciplinary is biggest level of integration. It involves of the creation of a universal system, without outstanding boundaries between the disciplines, meaning a general theory of knowledge systems which unites these diverse possibilities by means of regulated transformations and consultancy.

Reflecting on Piaget's definitions, the research could perceive that homeopathy used in agriculture could set an example as transdisciplinary discipline, opening dialogue space amongst agronomical, sociological and therapeutic disciplines, putting down the boundaries originated from different forms of knowledge, rearranging them in order to build the means for a true integrative, agroecological and holistic society. One the expands beyond the one health dialogue (MÜLLER, 2012; ROGET et al., 2020) – because that one doesn't include the environment. Whereas something like a one vitality would do.

However, despite the great transdisciplinary potential, the diverse professional groups which work with homeopathy have led to disputes about who is legally authorized to work with it. In the recent years, there has been a dispute amongst stakeholder to whom such specialization should belong or be professionally reserved to (SILVA et al., 2022). When analysing the disputed contents, it's clear that some professional groups – mainly medical doctors and pharmacists - are claiming professional exclusivity, not really thinking of the benefit for homeopathy itself, but rather to their economic interests (ANDRADE et al., 2011; CARNEIRO et al., 2018).

When contrasting the experience of the interviewees with the experiences of other research groups who deliver extension courses and the process of education in popular homeopathy (ANDRADE e CASALI, 2018, BONATO., 2015; BOFF et al., 2021) it's clear that such position should be criticized. Homeopathy is also defined as science and art of healing, and this means that with full immersion and dedicated study and practice on its philosophy and methodology would enable people, regardless background to use its benefits. Homeopathy is also a social technology, thus belonging to society to use it freely accordingly to its necessity and will (KHOLER and NEGRÃO; SILVA et al., 2022).

5.4.5. What are the benefits and challenges of using Homeopathy and dynamized high dilutions (DHDs) in agriculture?

Most of the interviews agreed that the benefits could be classified in ecological, economic and social. Many of them argued that ecological benefits would outweigh any other benefits.

It was rather fascinating to see how the ecological benefits were perceived for some of them:

> *For me, what I mean by ecological benefits is literally to see the environment boost its life. And through that, to understand and see that pulse of life that exists in our organism in all organisms on earth...In our food, feelings, emotions and the relationship, with others, with the collective and with non-humans, with the ecology of the earth…"* (A1/Brazil - 22/03/2020).

The reason for having ecological benefits is attributed to the nature of the homeopathic preparations, as justify for the Farmer 3:

> *"Homeopathic dynamizations are not toxic and do not harm the ecosystem they are treating, nor the farmers who handle them, nor the animals that consume them, nor the final consumers. In addition, its production does not produce contaminants, as is the case with most phytosanitary products and synthetic fertilizers"* (F3/Spain – 25/01/2022).

As for the economic benefits, the justifications were pragmatic:

> *"Homeopathic remedies are cheap. They don't present significant increases in production costs. In addition, some preparations could be made on farm"*. (F4/USA – 21/07/2021).

The interviewees had different awareness regarding the social benefits:

> "*By respecting the environment, the application of homeopathy can guarantee a healthy, toxin-free diet that benefits producers and consumers, affecting a better quality of life and better health"* (F1/India – 03/02/2022).

> "*Alongside the use of the HDDs itself, there is a constant knowledge building between all parts involved in the method, creating a sense of mutual value* (R3/Germany – 09/11/2020).

After asking about the benefits, I presented to the interviewees the main difficulties identified in the survey and literature and, asked if they agreed with them or if they could add any other. They were categorical: the difficulties identified were precise. However, for some of them, the practical issues were the mains challenges whereas for

other societal issues were the critical challenges. Overall, they agreed that the main challenges on using homeopathy and high-dynamized dilutions are a) how to adapt the method of symptoms selection to plants from the Materia Medica; b) the potency selection and mode of application; c) lack of governmental support; d) criticism over the homeopathic method.

After having their opinion, I questioned the interviewees thoroughly about the challenges and how they dealt with them.

5.4.6. How to select DHDs and potency?

Before selecting a DHD, there has to be a symptoms collection. It was very thought-provoking to notice that interviewees, comprehend that no matter if it was a pest or a disease problem, these organisms were indicators of an ongoing unbalanced management process. In this sense, the first peculiarity of this approach is that Homeopathy is not targeted to act against the organisms, but rather to bring it to its homeostasis back through a response of the plant itself.

Following the participants approaches, the research was then able to categorize their anamneses strategies in two main original categories. This was done that realizing that such categorization could help further research and practice, serving as technical term to be used for other peers when referencing their anamneses strategy, either in research or in the field. The formality of a definition like the ones suggested here, only objects orientation not a rule and its passive to be improved. With that been said, the anamneses strategies according to the participants are given:

- Morpho-Physiological Anamneses (MPA)

The MPA is a comparative method to select symptoms based on the morpho-physiological function affected in the plant or the main complain, consisting in observing the primary cause of complaint.

As the advisor “A3” from Brazil comments on that:

“*The focus is the plant and its main symptom, the main complaint. And why is that? A plant is like a revealed photo. Lots of times you make the soil analyses, and the nutrient content is alright, but then the compacted soil comprises the evolution of the crop. So, the plant reveals the vitality of the system. Because the plant reveals the whole dynamic. A pest is just a manifestation of the condition of the system and therefore the*

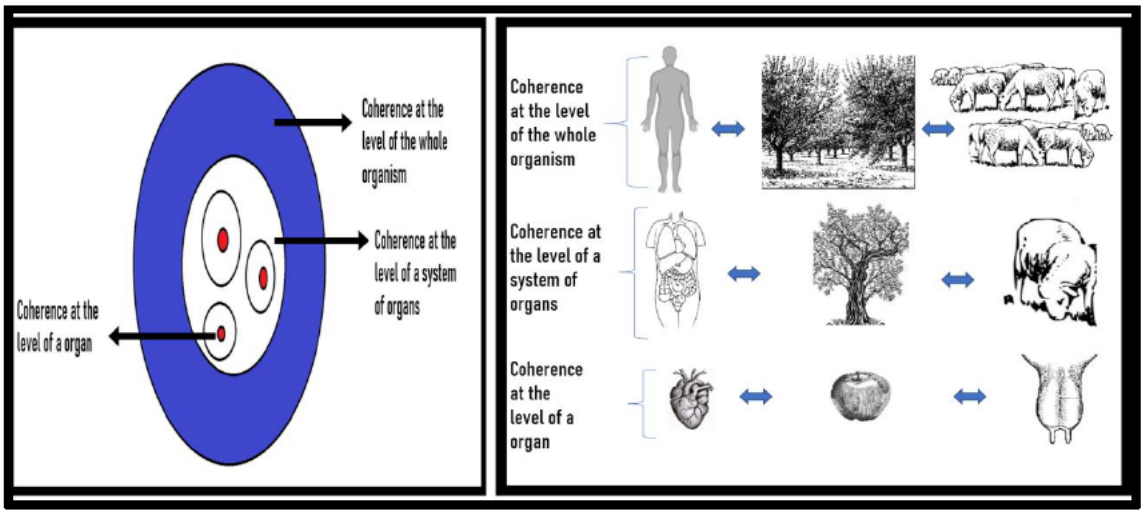
vitality of the plant. The question is not the organism, which is taking advantage from the system, so we observe more the function affected in the plant. The organ affected and the sensation that it brings – related to Indian homeopathic school. (A3/Brazil – 17/09/2021).

In this aspect, the morpho-physiological functions affected in the plant are compared to similar parameters in humans and animals, because they allow a direct connection to the *Materia Medica* e.g., plant root systems to the digestive system in animals or humans – both responsible for nutrient assimilation – or the close relationship between the soil microbiology and plant roots and the ones of human and animal gut microbiology, triggering metabolically responses or, the budding structures to the reproductive system, etc. This approach aligns with the theory of coherent/similarities (figure 36), as proposed by Manzalini & Galeazzi (2019). This concept is similar to the understating of the biodynamic farming.

According to farmer F1 from the UK:

Even though plants are different organisms than animals and humans, they still have similarities in their structure and functionality, so it's possible to correlate them. I observe first which part of the plant has been attacked. After that, other piece of information, such as the management used helps to picture the image of the disease (F1/UK – 03/03/2021).

Figure 34 - Levels of coherence/similarities to help select symptoms and what needs to be healed



Source: adapted from Manzalini and Galeazzi (2019); Boff et al (2021).

After correlating the morpho-physiological function affected, it's possible to study remedies in the *Materia Medica* that are strongly correlated to them, for instance, with digestive or reproduction systems, or even limbs, shape etc. In this method all variety of remedies – ranging from animal, plant or mineral – could be potentially selected to treat the organism.

The MPA collection has as its strength being a very pragmatic approach, that allows one to categorise information for later comparison with *Materia Medica.*

- Bio-Physiological Anamnesis (BPA)

The BPA is an anamneses method that focus on selecting DHDs linked to a bio-physiological response in the plant or animal. In this approach, the primary cause of complain will be linked to a biological function, e.g., the element phosphorus (P_2O_5) in the plant and animal organism (production of ATP). In this case, a lack of phosphorus in a plant would compromise physiological functions related to respiration, reproduction and plant development. Such set of characteristics could be correlated with the ones displayed in the *Materia Medica*. It follows a hierarchy level, presupposing those preparations should work better respecting an ecological level of interaction. In resume: a) mineral and plant preparations should be used for crops; b) mineral, plant and animal preparations should be used for animals.

The advisor "A4" from Germany explain her point of view:

I've noticed that remedies used under an ecological trophic organization or as I call it, an energetical assimilation level works better. It delivered me consistent results and for four years now I'm basing my anamnesis and remedies selection based on this approach. (A4/Germany - 23/02/2022).

Another advisor "A3", this time from Brazil similarly comments on that:

Considering the anamneses under ecological functions, is a reliable source, to observe the reactions on plants. So, if we know that plants respond to K, P_2O_5, Si etc.…

and that the deficiency of that element can cause standard malfunction of their physiology, that's possible preparation to be used. (A3/Brazil – 17/09/2021).

The BPA doesn't assume the DHDs acting as a source of nutrition, but rather as resonating signals, displayed for the plant's physiological perception, helping them to direct their bio-physiological efforts towards the resonating pattern.

A very interesting example of this approach is shared by farmer F3:

"*Whenever I'm walking through my orchard and the vegetables plots, naturally I'm always observing their development…as soon as I see any sign of intense alteration on their development, such as colours or an increasing in level of disease, I know it's time to signal the system with the homeopathic preparation. See, with my apples trees last year, even though the nutrition was adequate, many fruits showed "bitter pit" symptoms. So, I sprayed Calcaria carbonica 30CH in order to signal to the plants that Ca mobilization was needed to stop the development of the lesion and recover the balance. I was not fertilizing it, I was adjusting the plants physiological disturbance by means of a homeopathic preparation, based on a nutrition element that helps them to solve that problem. Almost like saying…hey, attention to calcium, please. (F3/Spain – 25/01/2022).*

There is one more method to be taking in account, even though not utilized amongst the other stakeholders. It's called holon-anamnesis, and it is proposed by the Advisor "A5" from Mexico who is an agronomist. In accordance with his approach, for using homeopathy in the agroecosystem, the holon-anamnesis takes into consideration the metabolic profile of plants and animals to select the remedy. As he comments on that:

"*Most plants have very similar primary metabolisms; however, the secondary metabolites are variable and numerous and are very specific from plant to plant. And why are they specific? Because plants co-evolved in a certain environment, coexisting with certain organisms, and thus the response developed by the plant is the cumulative of the environment in which it developed. After comparing the secondary metabolites that they share - it means that they are plants that co-evolve together, that means that their biota also has to be co-evolved.*

For a very practical example let's take the strawberry crop. In nature strawberry grows close to Pinus forests (sub-forest environment). Both share an environment of evolution. Accordingly, Pinus and strawberry have similar secondary metabolic profiles. In this case, to be used in the strawberry, a bionosode made of the Pinus or from the microbiology found in the soil where both developed could be used to treat the strawberry (A5/Mexico – 08/04/2021).

As mentioned in the begging of this section, the objective if this question was to cluster the main anamnesis strategies used to select DHDs for plants, hoping that they could be useful for future research and use in the field, serving as reference term. I believe they could be used together or separately and also complemented by some other approach. There are no best approach and it's also clear that anyone who uses Homeopathy, could still make use of its art aspect to select symptoms and therefore a preparation. And for that it is meant, when considering the different backgrounds from the interviewees, The research suggests that with experience and immersion on homeopathy, one could find by its own means the best way to do an anamnesis and proper select a preparation. If we consider the information collected via survey, where DHDs users tend to source their advice from books and other peers, that aspect its enhanced.

Next, interviewees were questioned the about potency selection and mode of application.

5.4.7. Potency selection and mode of application

The challenge is based in two aspects. Firstly, because the potency of the preparation is widely reported in literature as being crucial for sensibilizing the organism to the preparation. Secondly, the farmers stated in the survey that there is doubt relating the best way to apply, if either via irrigation or via spraying the preparations. So, the research delves on it with the interviewees.

- **Potency of the DHD**

When analyzing other studies, it's possible to observe a wide range of potencies employed (HANS et al., 2020). The justifications for using different potencies are: The DHDs possess an undulatory nature, therefore a wide range should be tested; It is considered part of the state of the art to have the sensibility to select the appropriate potency.

It was ratter interesting to know from the interviewees that basically two main aspects were considered on selecting the DHD potency: The depth of action on the organism (to physical or psychological) and the longevity of the effects. In this study, the interviewees basically indicated two main potencies to be used in plants: 12CH and 30CH.

Advisor “A3” from Brazil brings to light on that:

> “*Hahnemann is the most pragmatic one, so I chose to go with him. When I started to study the Organon, at the paragraph 270, Hahnemann states that he uses only the 30CH. Also, Hahnemann said that the best way to select a remedy is to feel the remedy action on yourself. So, I started to make the experimentation and keep a record of that. So, when testing different remedies on myself, I realize the point where it starts to have a clear action over the organism – mental and physical – and that was the 12CH. So, for that reason I use 12CH as a trigger potency to unchain the vital reactions on the systems and, the 30CH to conclude the protocol (A3/Brazil – 17/09/2021).*

Farmer “F2” from UK also comments:

> *I tend to use 12 CH because it’s the limbo one, it’s the starting potency. If can’t see response in a few days, it time to signal the plants with higher potencies. Furthermore, the two potencies are very common to be found ready to go in homeopathic pharmacies (F2/UK – 28/08/2020).*

Agreeing with the collogues, farmer “F1” comments:

> *Commonly we can find on the internet and pharmacies remedies starting with the 5X, 10X to 30X. I know that varies from country to country, bur here those are easy to get in those potencies (F1/India – 03/03/2021).*

This research investigated in literature to see if the stakeholders’ perceptions were shared with experimental conditions and the work from Jütte and Riley (2005) supports the interview's perception. With those aspects considered, the role of potencies would be as given: high potencies (≥ 30CH) are preferable if the emphasis of the symptoms is chronical; low potencies (from 10CH to 29CH) if the focus of symptoms are physical/temporal, at least at the beginning of treatment; high potencies can/should be repeated less frequently; low potencies can be repeated more frequently; low potencies are often used in acute cases; low potencies are often used in conjunction with other treatments; The use of constitutional medicines in low potencies can be used to facilitate the response to the same remedy in a higher potency.

By triangulating the data from the agronomical experiment (chapter 3) with the survey (chapter 4) and interviews, this study can confidently suggest the use of the potencies 12CH and 30CH for treating plants with dynamized high dilutions. However, as seen in the literature review, focused studies evaluating the biological responses over different potencies could contribute significatively to understand better the effects of

DHD in plants. Also, this study has limitations on geography, DHDs tested and model crop used, therefore, more studies should be done in that matter.

- **Mode of application**

As mentioned previously, the mode of application is another issue identified when using DHDs in agriculture. The recurrent doubt comes from its use for human treatment, in which the homeopathic remedies are taken it directly via oral by the individual. This issue is a problem in agriculture. Should one spread globules or dissolve them? Should it be applied via irrigation or sprayed? The interviewees were asked what their experience with that were.

The unanimous agreement point between all participants was that the preparations should be applied via water. For the animals, it could be via water source or moisturized in their feeding and for plants by means of irrigation or spraying. These results are strongly correlated with nature of water itself as I presented in my introduction chapter.

This feature elucidates the phenomena observed by researchers, advisors and farmers interviewed in this research who have observed an increase on the effects of the homeopathic preparation when they are applied via water, eighter irrigation or spraying.

Researcher R2 explain his point of view:

"*My best results over ten years of study were applying homeopathic preparations is via water. It seems the remedy is better absorbed by the plants*" (R2/Germany – 18/11/2020).

That perspective is supported by field results as A3 remarked:

"*My experience led me to prefer irrigation. But this is the sort of the thing that is always influenced by what the farmer prefers and have available in the farm. I have done both methods. But again, in terms of my personal experience, my own observations and the ones that farmers obtained, I can tell you that with irrigation the plants response is much faster"* (A3/Brazil – 17/09/2021).

Farmer F3 corroborates researcher and advisors' viewpoints:

"*I noticed that via irrigation the remedies are much faster*" *(F3/Spain – 25/01/2022).*

However, researcher R4 caveats his results:

"*We have observed that via irrigation, the plants response is increased. Of course, some preparations like the silica or caustic preparations work well via sprays*" *(R4/Italy - 22/02/2022).*

In this sense, it would be possible and efficient to apply the DHDs via irrigation or depending on the DHD spraying it. Such practices are well assimilated by farmers because irrigation systems and spraying are commonly used in agriculture. For researchers, using controlled volumes of DHD applied via irrigation are also easy to incorporate on their studies, no matter if in the field or lab experiments due to the nature of controlled experimentation.

It seems that the stakeholders experience and observation corroborate the phenomena of water being capable to retain information. Because the DHD information appears to be contained and spread in the water. This controversial issue has been proposed by authors who evidenced that any substance that gets in contact with water leaves a trace, due to water electrochemical nature, forming clusters of the substances that are dissolved on it, thus adopting its properties, recording this information and being measured for example with irradiation or crystallization patterns (RADIN et al 2006; HANKEY, 2019; MEESSEN 2021).

- **Volume and frequency of application**

In the literature review and survey another current uncertainty when using DHD in agriculture was the volume necessary to impregnate the treatment solution with the remedy information. If in one hand, the manufacturing of the DHDs follows rigorously and thoroughly the methodology as described in the pharmacopeias (BRASIL, 2011). On the other hand, the homeopathic preparation volumes most of the times follows the practitioner's own experience.

In fact, with this question there were no unanimous reference parameters. Each interviewee had a different justification for the volumes used and for some of them, the volume will always depend on each case, being a matter of intuition. However, mainly in the group of the researchers and advisors, it was possible to identify a more structured framework. Usually, that was related to the surface area to be applied and commonly available barrels in the market (200 L, 100L, and 50L), that information is clustered below:

- 20 ml of the HDD per hectare
- 10 ml of the HDD per hectare
- 10 ml of the HDD per 1000 L of water
- 5 ml of the HDD per 1000 L of water
- 5 ml of the HDD per 200 L of water
- 1 ml of the HDD per 50 L of water
- 1 ml of the HDD per 100ml or 50 ml of water
- 10 globules of the HDD per 50L of water
- 25 globules of the HDD per 1000 L of water

For those who were working with these reference values, the justification was exclusively based on their own empirical experience, developed across years of practice, accumulating achievements and failures that finally drove them to reliable results.

In this case, the values reported could be considered for further studies and application. However, It is also concluded that the volumes to be used will depend on one's experience and should take in consideration the material available, respecting the agreements between the involved parts, so that they could develop their own methodological process. Off course, in cases that a commercial product is used – for example a commercial brand of homeopathic preparation - the best way is to follow the product recommendation.

Regardless the volumes to be used, the process of dynamization of the homeopathic solution prior to the application was seen as fundamental because it is with this technique that confers the solution its property or in researcher "R3" words:

"*Activate and imprint the information into the solution*" *(R3/Germany – 18/11/2020).*

Different from the volumes, the frequency of application had many convergent strategies amongst the stakeholders. The interviewees considered: a) dynamics of pest and disease (incidence and severity); b) critical moments on a crop development, e.g., post-germination, flowering, fructification, or pre-harvest; c) events of stress such as seedling transplant, drought, flood, frost or hail.

The reported frequency varied from 3 to 7 applications considering different factors for different crops and situations. Advisor "A3" comments on that:

"*You should always consider the peculiarities of each crop and also any environment factor. Other than that, the farmer perspective must be considered,*

because their experience will tell you about the dynamic of the on-gonging situation. Then you'll be able to adapt your protocol (A3/Brazil – 17/09/2021).

This quote mentioning the collaborative role build between the involved parts (farmer and advisor or researcher), where the experiences are placed together, in order to make a management decision. This approach differs drastically from the ones practiced nowadays in agriculture, mainly from the ones offered by governmental extension agencies or big companies advice services, where the technology is merely transmitted in a superficial and commercial way.

The last subject discussed inside of the DHDs selection focused on the use of Nosodes or Biotherapic. In contrast to the strategies based on similitude approach of *likes* cures *likes*, the use of Nosodes, a method based in the principle of equals - *same* cures *same* is widely used by the interviews and survey respondents. The use of bionosodes is discussed next.

5.4.8. Nosode – the concept of dynamized high dilutions developed into its most pragmatic facet: What are your impressions?

Nosodes as explained in the introduction chapter, are dynamized high dilutions made directly from the target organism/problem organism. They are produced following the homeopathic method (dilution + succussion) but, the remedy does not operate under the similitude principle as it does with an ordinary homeopathic remedy (RUPP et al., 2012).

The word come from the Greek "*noso*" meaning disease, thus indicating the pathological root of nosodes. This term is also linked with the Latin word "*noxa*", related to noxious or damaging. Nosodes came into use since the earliest experiments by Constantine Hering while he was in South America between 1827 and 1833. Nosodes have been explored and experimented by many from time to time and there are approximately 150 nosodes mentioned in the homeopathic literature, but very few are part of official homeopathic pharmacopoeias (SAURAV and BHARTI., 2015).

To illustrate the nosode action, we shall look to the study published by Giesel and colleagues (2017): a plantation is under attack of leaf-cutter ants; the insects are foraging the plantation; a nosode is made from the insects; the Leaf-cutter-ant nosode 30CH is then

sprayed on the insects' colonies and path. The ant's foraging action is reduced, without killing the insects. Harmony is brought to the system.

The nosode preparations are widespread and used by all homeopathy stakeholders' categories. However, their opinion diverges on how to use it.

Advisor "A3" made his considerations

> "*Nosodes have a great potential. I test them since 2012, but there are some limitations. Nosodes doesn't work under the similitude principle. Mainly, because the suppression that it causes is almost irreversible, sometimes killing the plants. And there is no counter remedy to cancel its action. It works like a shock action. So, in those cases -an infestation of insects or high spread of a disease - it can be an option. However, the resistance or the comeback of the primary cause of complaint comes easier and faster with the use of nosodes. Also, homeopathic preparations act over all the plant. The nosodes acts only over the target organism…I've seen this happen many times. With eucalyptus seedlings one time, we used nosode to treat insect attacks. After the first round, we diminished the insect's attack. Few weeks later, the incidence of attack was higher, and a vascular disease appeared. It was clearly a bad response from the from nosodes (A3/Brazil – 17/09/2021).*

When comparing the interviewee report with literature, the research found that Rupp et al (2012) in their study using nosodes of *Anastrepha fraterculus (Wied*.) in the Peach culture, verified similar scenario as described by advisor *"A3".* Although there was significant control of the insects in the first harvest there were no significant differences in the second harvest with an increase of population in the second year. Nonetheless, Carneiro et al (2022) successfully promoted significant reduction in the size of the angular leaf spot lesion in bean as well as in the severity and number of Septoria lesions in tomato using nosodes of *Pseudocercospora griseola* and *Septoria lycopersici* respectively.

Advisor "A3" has a different perspective on the use of nosodes. For him, the nosodes represent a didactical way of learning the complex homeopathic principles:

> "*My experience tells me nosodes are fast action tools. It's putting out the fire. But a proper remedy selection should always follow its use. Nevertheless, nosodes are useful, and I'll tell you why. There is an opportunity. It gives the farmer the opportunity to try the homeopathic method by themselves. Nosodes are a very pedagogical tool (A1/UK - 17/05/2020*).

Considering research data and the interviewees perspectives, the research would argue that there is value on researching nosodes effects in agriculture. It also agreed that its main potential resides in the fact that the concepts of a dynamized high dilutions are easily grasped with the use of nosodes, and therefore should be included in agrohomeopathy training. This kind of knowledge could prove itself very useful for helping farmers in rural communities far away from commercial centers, offering to them a tool to act in case of urgency. We have to create a system that encourage the farmers to learn by their own experience, and homeopathy and the use of dynamized high dilutions can help with that task.

Finally, after understanding the technical aspects of using DHDs in agriculture, the study asked about the effects of DHDs, specifically trying to understand how they perceive the health and vitality in the agroecosystem.

5.4.9. Regarding the connections between the use of Homeopathy and dynamized high dilutions, and vitality: How do you perceive vitality in the agroecosystem?

One of the most notorious characteristics of Homeopathy and dynamized high dilutions is action over the vitality of biological systems (JÄGGER et al., 2015, BONATO et al., 2015; BONAMIN et al., 2018). Such effect is caused not directly in the organism, but rather as response to information stimulated by the homeopathic preparation, or as Hanemman (1842) mentions, a secondary effect over the organism the vitality.

In the introduction chapter, the nuances of vitality were presented. However, as Döring et al (2015) argue, the debate on plant health and vitality has been for a long time in discussion and for most currently agronomists and researchers, plant health or plant disease is resumed only to the hygiene of plants in terms of trading and use of phytosanitary products, focusing on plants being free of certain strains or organisms, where officials need to have some kind of control, from an epidemiological point view.

This point of view exposes the commercial, materialistic and anthropocentric perspective that has placed agriculture to face its current problems: intoxication of ecosystems with pesticides, degradation of campesino knowledge and traditions, compromising food security and diversity (WANDERLEY, 2009; GLISSMAN, 2014; PIMBERT, 2015; ALTIERI et al., 2017).

In fact, the discussion over plant health, plant disease and plant vitality is limited. Or as in the words of R4:

> "It's *something that people who are trained in agriculture these days don't even think about. It's so engrained that technicians don't even question it (R4/Germany – 13/07/2021)".*

However, it could be identified that the use of homeopathy in agriculture, has offered a different perspective. One that is aligned with agroecological principles (BOFF et al., 2021). One that focus on the construction of collective health and promotion of vitality (BONATO et al., 2015).

Researcher "R1" explains how homeopathy and the concepts of health and vitality helped her to integrate concepts of human health to the ones of the health of the agroecosystem:

> "*Health and vitality, they are different but not necessarily disconnected. I can see health only in a collective view. It will incorporate social, economic, political, cultural, historical, and environmental dimensions. And how am I going to talk about the health of the human being, detached from nature, detached from the nature of the earth, impossible! That's where homeopathy is useful. It helps us to understand these connections, due to its philosophical and methodological structure. When we work on this set of elements, the vital energy is favored. You have to understand vitality as a pulse of life that exists in our organism in all organisms on earth. So, this pulse of life within us. Vitality it is not only the vitality of people, but vitality is also linked to a greater connection. The vitality is in things being born (22/03/2021)".*

Researcher "R3" from Germany goes further and contrasts health and vitality:

> *Yes, I think they are different. Health to me is a positive consequence of a vitalizing being, it is an effect originated from a balanced and harmonious energy flow. Vitality is what drives an animal, plant or human to be healthy. It is this energetic force that drives the body towards this momentum of health. Vitality is difficult to define but it is easy to see and perceive it. Health is the status. Vitality is a force (R3/Germany – 20/11/2020).*

These two quotes reflect aspects of a vitalist perspective. As seen in the literature review, the vitalist theory has lost space in academic debate due its notion of an immaterial force influencing the biological systems development (BANCHETTI-RABINO, 2011).

It's also possible to grasp the use of the word "force" but clearly not meaning the physics definition, but rather as an energy-like force. When investigating through different research and theories, looking for hypotheses that could explain this sense of "energy-like", I found myself perplexed and intrigued. However, after meticulously reflecting on it, the research results support that homeopathy and vitality might operate

under energetic resonance and quantum mechanics (SHELDRAKE, 2009; HARAMEIN et al., 2013; Al-KHALILi and MCFADEN., 2016; PLANCK and BOHR, 2019).

Going further in the analyses, researcher "R3" comments that the lack of space for vitalist perspectives inside of conventional agriculture schools exposes a lack of communication between disciplines:

> "*It has the history to find a force behind the living processes, and it was discredited by cartesian science, but nowadays, it clear that its back to the discussion. Nonetheless, if we bring this discussion as we are doing here, there would be no communication, because we couldn't really communicate. We don't speak the same language (R3/Germany – 20/11/2020).*"

And what language is that I asked myself? Reading in between the lines, that's the language of perception and that is subjective, something that natural sciences struggle to incorporate in its analyses of reality (HARNESK and ISGREN, 2021).

It was ratter interesting the nuances amongst the stakeholders regarding vitality. Researchers still want to be able to detect it, however using methods that can express vitality.

Researcher "R4" from Germany says:

> "*Maybe we are not able to measure this force directly – at least at the moment - but we can definitely measure the manifestation or expression of it in terms of complexity, organization and quality using fractality, refractometry, sensory food analysis etc. (R4/Germany – 19/11/2020).*"

For the advisors, the importance on discussing and identifying vitality on the agroecosystem resides in the fact that it creates space for dialogue and a critical view over agronomical actions. Advisor "A3" comments:

> *"These two definitions are so broad in what they mean that I see really no point of defining them, this is health this is vitality. You cannot give a definition; you can instigate questions. That's the true value of this terms. Other than that, the terms are useful because it's possible to relate to them accordingly, in a way that some understating and communication can be grasped (17/09/2020)*".

When I was reflecting on this, I could relate to Freire's work (1995), who argues that when trying to transfer agriculture technologies to farmers, the dialogue space is crucial to adoption of that technology by them. More importantly in way that worldview is respected leading solid transformation in society.

It was ratter interesting to notice that farmers are more concerned in perceiving it rather than measuring it.

Farmer "F3" express that:

"*It is not useful as a scientific term, a measured one. Vitality is perhaps the only term that can bring to each and every person a personal association to something that is filled with life; And, make them conscious about it. Personally, it's how I would like to feel and see my surroundings…so yes, vital is almost a feeling (F3/UK – 28/08/2020).*

In that same sense, Farmer "F4" from the USA says:

"*Everyone thinks what it should mean, but it's different to everyone, and it's okay. Its only for science that we need a very specific definition on what it means and exactly ways to measure it to be real. I ask myself, does it worth to know it like this? You see when you decompose things and then measure and you put it together again, it's not the same thing…or as indigenous saying – if you spent too much time trying to see where the bird is you miss its song" (F4/USA – 21/07/2020).*

Farmer F3 agrees with his peers:

"I see sometimes that science struggles to understand intuition or perception, maybe science is not the best way to approach it or to understand it, because it's a living phenomenon and life will always be seen differently from different eyes (F3/Spain – 25/01/2022)".

From these quotes, I could relate to the arguments made by Hoffman (2007) about human values in agriculture. According to the authors, to optimize the collaboration between farmers and scientists in the field of technological innovation and perception of its benefits - in this case homeopathy and high-dynamized dilutions to promot vitality in agriculture – we must stimulate decentralization of knowledge, informal modes of experimentation and externalization of tacit knowledge. By better understanding such issues, researchers may better define their own roles in the research process, acknowledge their own strengths and weaknesses, overcome communication gaps, and develop creative solutions for problems.

Perhaps, the greatest contribution of the vitality in the agroecosystem is to revisit the primordial values and interactions of humans within the cultural development of agriculture. Mazoyer and Roudart (2010) in their work on the history of agriculture, point out that humanity turned its impulse of development based on values that aligned collective welfare and societal development.

Maybe perceiving vitality in agriculture can make us question what our relationship to the earth is and, what it means for our human existence and evolution.

5.5. CONCLUSION

By using the interviews, this study acquired in-depth information from high-quality responses addressing specific knowledge gaps identified in the literature review and survey. The interviews allowed the study to comprehend similarities and differences in how Homeopathy and dynamized high dilutions are used in different realities and perspectives. In doing so, this study was able to cluster pragmatic management information such as the selection of DHDs and potencies, mode of application and volumes, etc. But also, the phenomenological knowledge necessary to make sense of that data.

The interviews exposed how different professional backgrounds can benefit from learning and using homeopathy, and more importantly that homeopathy is a scientific subject with a real transdisciplinary potential, therefore, creating knowledge bridges and facilitating communication between different forms of knowledge, creating dialogue spaces that can help to spread and create new forms of knowledge aligned to the interests of sustainability and social equity.

In addition, the practical information on the uses of homeopathy and high-dynamized dilutions in agriculture laid the foundations for a protocol to be tested and used for further research and agronomic practices in the field.

Finally, the discussion on vitality revealed that it inspires revisiting the culture of agricultural development and the primordial values and interactions of humans, putting together as outcomes the ecological, social-economic, philosophical, and spiritual benefits. Not in a hierarchical way but rather as one interdependent to the other. Such a holistic approach can ultimately help humanity to evolve towards an integral life, helping humankind to restore its connection and respect to nature.

6. GENERAL CONCLUSIONS

This chapter summarizes the main conclusions from the previous chapters which examined the contributions of Homeopathy and the use of dynamized high dilutions (DHD) for the sustainability of agroecosystems. The research questions addressed in this study were:

Can dynamized high dilutions promote agronomic responses in plants? How do farmers experience the use of Homeopathy and DHDs in agriculture? Could a deeper understating of Homeopathy and vitality in the agroecosystem help to improve farming and research strategies?

To answer these questions, this research was inspired by phenomenology, heuristic inquiry and grounded theory, combining social and natural sciences methods. Firstly, a systematic review addressed how vitality has been addressed in agronomic studies. Next, an experiment was carried out for two years testing the effects of DHDs as plant bio-stimulators in promoting crop production and development in strawberry culture. After that, a web-survey was circulated to farmers who utilize Homeopathy and dynamized high dilutions. Finally, a series of interviews with researchers, advisors and farmers acquired in-depth information on the uses of homeopathy and dynamized high dilutions.

6.1. Insights on vitality

When this this research started four years ago, the question on whether it would be possible to promote vitality in agriculture using dynamized high dilutions was a daunting challenge. It was knowing that in order to answer the research questions, I'd have to interconnect different sets of skills and knowledge. The study would have to orbit around profound philosophical questions regarding the nature-human relationship. This investigation lead the researcher through an ever-growing flow of information, interactions, and perceptions. I had to humbly put aside my own active nature and favour my role as an observer to encourage perception which in turn lead to experiencing.

This research learned that experiencing vitality is a matter of perception that will depend on the ontological foundations of the individual. Especially in western societies, the problem is trying to bring notions of reality from outside into the mainstream

paradigm. The way this research was conducted helped to minimize this situation. By combining natural and social sciences this study was able to complement different perspectives that helped to gain a more complex understanding of the phenomena.

The holistic approach of Homeopathy in agriculture talks about engagement and relationship of the environment and its beings. These insights led to reflect on different ontologies. Within these ontologies, perceiving vitality is perceiving how the future can unfold, enhancing life manifestations by stimulating biodiversity maintenance and using agroecological farming systems to produce food.

As discussed in the general introduction chapter, the concept of vitality or life force, as a metaphysical force has been addressed in Greek (pneuma), Chinese (chi), Indian (prana) and other cultures but has faced criticism by the western scientific community because it deals with the "immaterial paradigm". Heisenberg's (1901-1976) Uncertainty Principle told us that the very world is a ghostly and insubstantial place that only solidifies into clear existence when we set up a measuring device to interact with it. Heisenberg showed that this process reveals only the characteristics it was specially designed to measure, just as each instrument on a car's dashboard gives information about how a particular component works (BUSCH et al., 2007). So, measuring or quantifying the vital movement of life exclusively by means of measurements is not only inappropriate, but it must also be perceived in its complexity of manifestation.

This affirmation exemplifies the criticism that mechanism research has been facing when needing to integrate different aspects of a studied phenomenon. To this research specifically, this statement confirms what my literature reviews and interviews as well as in the survey data show that vitality express itself on a myriad of parameters.

In this study, it was observed that complexity by the terms collected in my systematic review, the objective data from my trials, and the qualitative information provided by the survey and interviews. The research evidenced that vitality is the manifestation of life and we as researchers, farmers and people of the world have different ways to perceive and therefore different ways to measure and promote it.

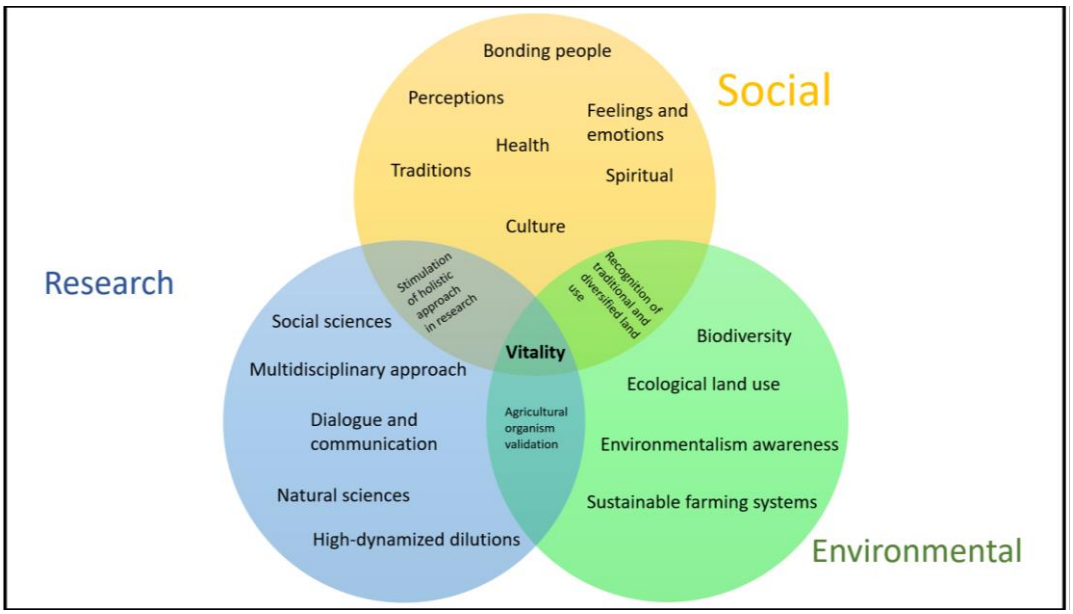
In addition, it could be comprehend that Homeopathy and its ontological and epistemological nature (Figure 37), offers the potentiality to understand the environment or territory by encompassing the socioeconomic-biological factors, on what integrative homeopathy calls the agriculture-organism. This perspective is fascinating because comprehending the agroecosystem as a living and connected organism is a paradigm breaker that serves as ontological bases for a agroecological transition. Regardless the

individual and complex characteristics that any agriculture-organisms might have at its very basic core lies a very simple truth: the system is alive. Therefore, the way humanity interacts with it has to be one of harmony or homeostasis.

Another insightful aspect from the research came from the perceptions on vitality, in particular the notion that the vitality-lifeforce-phenomenon express itself as well in feelings. As seen in the chapter three, happiness was one of the most common words used by the participants to explain how they perceived vitality. This is fascinating because it illustrates the vitality force-like-nature to its most subjective aspect, still having great impact on people's lives. Because after all, seeking happiness it's the amalgam – the perfect fusion- to a fulfilled life.

When looking into the definitions given by the authors and comparing them with the ones obtained in this research (by data triangulation), it is clear that vitality is associated with the capacity of performing appropriately, making life manifestation possible. In addition, under the vitality pulse, comes resilience, growth, development of biodiversity, ecological functionality, and stimulating life in a harmonious way.

Figure 35 - Vitality and its harmonizing spheres



Source: developed by the author (2022).

The research demonstrated that vitality is also expressed in terms of the quality of development and health of these organisms and society. Interestingly, the study suggests

that vitality and health are considered as different, and that health is a consequence of having vitality in this case, again – expressing a life force. It was possible to observe that when the term vitality is used, there is a direct thought connected to an impulse for life, whereas health reflects a physiological momentum. Moreover, because of its holistic nature, vitality can be used to describe potential characteristics such as in food quality, systems functionality, environment quality or mode of action of certain agriculture methods, etc. On the other hand, health is linked to food composition, organ functionality. Vitality refers to holistic knowledge, health refers to mechanistic knowledge. Both have value and to some point support each other.

Vitalist descriptions of natural phenomena tend to be qualitative, and most importantly vitalism views the causes of motion as inherent within matter all of nature. However, as this research discussed in the general introduction chapter, materialism and vitalism still maintain long-lasting disputes over fundamental questions in biology and nature itself. Lovelock (2016) suggests a broad approach to put together, soil, plant, animal and man wellness in one and indivisible system, believing that there is a link from soil to plant and from plant to livestock and humans, where there would be no separation because it would be conceptually wrong to separate it from health of soil, animal and man. Recently brought to this debate, modern quantum physicists, although not advocating the existence of a vital force, maintains that life cannot be reduced to mere material interactions (DÜRR et al., 2002).

This research also explained that seeking vitality in agriculture creates a set of values and relationships between, plant, man, and the environment they share. Vitality allows for an applied integration of biology, ecology, and cosmology. The consequence of such ideas allows processes to shift the physical and intellectual as well as the symbolic, interactions between mankind and its environment.

It could be realized that Vitality emphasizes a systemic approach, because as the case is made, no singular parameter alone could explain a manifested scenario by itself. Only by combining and intertwining different parameter we can make sense of it. Vitality stimulates the conservation of the cultural and biological process, open spaces for autonomy and feelings, promoting consciousness regarding social aspects linked to collective wellness. The results of this research elucidated a different set of characteristics, that state/express an optimum state of existence or manifestation, no matter if it is for a biological system (seed, plant, animal or ecosystem) or a community. That optimum/harmonious positive feature could only be described in terms of vitality.

Therefore, this study proposes that any farming system should seek as its biggest objective the promotion and perception of vitality.

6.2. Contributions to academic knowledge and recommendations for further research

The contributions to the academic knowledge come from the questions posed in this study helped to develop the discussion about innovative sustainable methods (dynamized high dilutions) and ways to perceive their impact of them on agroecosystems (vitality). Also, the multi-methods used to encompass natural and social sciences perspectives offer an example of interdisciplinary research and the benefits that using this approach could bring to the development of scientific studies. In this sense, the contribution of each method used in this study to address the research questions is presented next.

How do farmers experience the use of dynamized high dilutions (DHDs) in agriculture? Could a deeper understating of homeopathy and vitality in the agroecosystem help to improve farming and research strategies?

6.2.1. Systematic review

The systematic review helped to answer the research question on "How a deeper understating of homeopathy and vitality in the agroecosystem could help to improve farming and research strategies and has vitality been addressed in agricultural research in the last 20 years?". It helped to determine to what extent vitality had been addressed in agricultural research.

The main advantage of using the systematic review was to find and bring together the available information about vitality in agricultural studies. Using the traditional narrative review, this study was able to describe and contrast results found in the systematic review, to understand the causal processes behind the vitality.

After systematically analyzing research on vitality in agriculture in the last 20 years, it was interesting to witness that vitality discussion didn't hold on to its metaphysical nature but rather for its effect on biological and social systems. The applications of using the term reside in determining the vivacity of a given organism or

system; its capacity to complete and maintain its life cycle and how the relationships derived from different organisms/systems could achieve an optimum state of manifestation.

The systematic review also evidenced the nuances between commonly associated terms, resilience, and vitality. As such, resilience is the capacity to cope with problems, adjust to changes, overcome obstacles, and resist adverse pressure – it is a value contained within vitality. Vitality is the characteristic of what is alive, it implies the energy and ability to live to develop, with, dynamism, activity, impulse, and impetus. It is the very impulse to become alive. Resilience is characteristic of a vitalized system.

The review allowed comparison between different terms such as organism vitality, plant vitality, ecosystem vitality, community vitality, and others and established similarities in their meanings. Overall, the terms expressed features related to resilience, growth and development of plants, animals, ecosystems and human values. These expressions of vitality were obtained from a series of measurements like morphological and physiological features, development and production, environmental stress resistance, resistance to pests and diseases, community interactions and activities, etc. This set of characteristics was considered manifestations of vitality.

It was also possible to notice a curious similarity between dynamized high dilutions and studies that used bio-stimulants to stimulate crop vitality. The principle of promoting a stimulus yielding a biological response on the plants, supporting crop resilience and development. There is a shared notion of achieving equilibrium or promoting the vitality, even though they are completely different methods. There was also a consistent mention of vitality as increase in the pollinator diversity, a fact that was confirmed later by the survey and interviews agreeing with that claim. So, it's possible to grasp an augmentation of life dynamics as a consequence of vitality.

In addition, vitality was associated to maintenance of agroecosystem services, although very interesting, I myself in doing agroecological research tend not to like the emphasis on the ecosystem services (ES) as mean to achieve vitality, simply because the term ecosystem services by definition means the benefits that people receive from healthy ecosystems. Therefore, in a certain way the counterpart, the benefits that people offer to the ecosystem are put aside. In that sense, it was very interesting to see that for some studies, the focus on promoting agrobiodiversity and the conservation of the cultural and biological process are the means to enhance the ecosystem vitality.

Vitality as presented by these authors and terms identified in the systematic review, allows for an applied integration of biology, ecology, sociology and cosmology. The consequence of such ideas allows processes to shift the physical and intellectual as well as the symbolic, interactions between mankind and its environment.

Finally, after reviewing vitality thoroughly, it was clear that the term stimulates the conservation of the cultural and biological process, promoting consciousness regarding social, agronomic and ecological aspects linked to collective wellness.

6.2.2. Controlled trials

The controlled trials were essential because they made solid landmark contribution regarding the research on homeopathy in agriculture, or "Agrohomepathy". This contribution was only possible due to a collective effort of the research teams. They addressed one of the research questions: "Can dynamized high dilutions promote agronomic responses in the strawberry crop?" The answer to that question is positive. The high dynamized dilutions of *Sulphur* 12CH, *Phosphorus* 12CH, *Kali carbonicum* 12CH, *Silicea terra* 12CH increased yield (25 to 30%), promoted plant growth, resistant plants to diseases and pests, and fruit quality.

The randomized block design, following a double-blind application and codding were essential and proved to be appropriate methods. During the trials, not knowing what treatment one is applying and, only objectively observing the changes that those treatments are influencing in the plants was thrilling. The result of that was week after week a growth in curiosity. This curiosity was only ceased once the statistical analyses and the codes were revealed. In a certain way, this method kept the whole journey interesting. After two years of data collection, the results were clear, the dynamized high dilutions acted as plant bio-stimulator influencing agronomic responses on strawberry plants.

The attributes assessed in this experiment were directly linked to vitality expression (as seen by the data triangulation from literature and systematic review). It's interesting to mention though, that many of the performance indices which the authors proposed in the systematic review as vitality expressors, considered components such as the leaf chlorophyll content, biomass and root development individually. In this study, however, it was included a much larger set of parameters that were analysed together, including evaluations on crop production, plant architecture, pathosystem dynamic, fruit

quality etc. In, addition the social methods brought a whole set of complementary understating of the vitality phenomena through the experiences lived by the participants who use Homeopathy and dynamized high dilutions. When triangulating this data with the other methods, it was possible to generalize some assumptions, like the mineral DHDs and the 12CH potency to be used in plants.

In this sense, this study stepped further on assessing as vitality manifestation in agriculture. The results obtained in this study as well as the approach used in this research - focusing on mineral-based preparations – could serve as a solid path to select DHDs for plants; but more specifically to enhance the production of pesticide-free strawberries, helping to build resilient agroecosystems through nontoxic or residual method and offer to the farmers a safe, efficient and cheap management technique.

The biological effects observed in plants and their response to the stimulus from the DHDs present an exciting prospect to agriculture research. These research results can benefit farmers to increase their yields and the health of their agroecosystems, and help consumers avoid contamination by pesticide residues.

The trials revealed how the DHDs behave in a controlled environment. For a further step on the research of agrohomeopathy, it would be interesting to bring the treatments that showed the best results to a field experiment. Due to the limitations on time related to COVID-19, the possibility to take this step in my research was compromised. In this sense, the recommendations from this study would be to conduct a field trials to deepen understating on the use of DHDs in agriculture.

It would also be useful to do more lab research on which of the preparations interacts best with which. Also, it would be interesting to investigate the combination of the homeopathic preparations with other agroecological management such as biodynamic preparations, due to the common features shared by these methods. This could potentially deepen our understanding of vitality in the agroecosystem.

6.2.3. Farmers survey

The survey was a very useful method, especially as the pandemic restricted face to face contact by researchers. The survey helped to answer, “How do farmers experience the use of Homeopathy and dynamized high dilutions in agriculture”?

The survey revealed that most farmers who used DHDs in agriculture are highly experienced in the use of the method (75% of the respondents using it for more than 10

years). They identify themselves as independents, not relying on certification but rather on their farming profile, mainly described as non-chemical, agroecological, permaculture and organic. Also, they are a very autonomous and pragmatic group who obtain technical advice on books and peer-exchanges.

The survey also identified the most common DHDs used in agriculture. Around 40 dynamized high dilutions were named, with the potencies 6CH,12CH,30CH and 200CH identified. This information is crucial because, firstly I could verify that most of the DHDs that were used in this research experiment are in the list of those most used by farmers and secondly, this information could be used for further experiments. By having the information on what is currently being used by the farmers, researchers could establish new experiments. Ideally, these experiments would test those preparations and potencies in various crops, therefore having a data set that would converge field and lab results.

Finally, the farmers surveyed described improvements in their health, their crops and their environment as well as an increment on their yields and costs of production. It was possible to verify that their main reason for using Homeopathy and DHDs is due to its environmentally friendly nature, with impacts also on their health and society. Likewise, farmers experience vitality in a very personal, subjective but still pragmatic way. Therefore, one could argue that homeopathy is contributing to development of scientific knowledge, structuring a worldview that is holistic and not limited by mainstream worldview, stimulating free thinking.

The research results made it possible to observe (due to data triangulation) that the connections between environmental, health and social motivations could also be rooted in these farmers' spiritual orientation. As discussed in chapter 3, farming systems that incorporate spirituality into their management interpret spirituality in terms of ethics, morals, values, and worldviews, combining spiritual values with farming practices, which in turn stimulates the emergence of social, cultural, and symbolic capital. This set of capitals means appreciating and valuing local knowledge, skills, expertise, and experiences embedded in individual perceptions, as well as interpersonal relationships built upon mutual recognition, dialogue, and trust between individuals. Eventually, these forms of capital will transform into symbolic capital, enhancing the legitimacy of transformative actions based on their reputation and credibility. Once more, these features are also present in the DHD farmer profile as the survey identified.

Correlating the reasons and benefits of using Homeopathy and dynamized high dilutions in agriculture, the research could comprehend that the farmers focus on high-

quality food production, foreseeing work in intimate partnership with nature and emphasizing an ecological, ethical, and spiritual approach to agriculture and food production. It is not just a method of growing, but a way of being, living, and of making meaning

6.2.4. Interviews

The interview phase explored the information obtained from 13 interviews with a group of international highly qualified stakeholders (researchers, advisors and farmers) that work with Homeopathy and dynamized high dilutions and helped to answer the research question on "Could a deeper understating of Homeopathy and vitality in the agroecosystem help to improve farming and research strategies?"

The results from thirteen interviews across 9 countries indicated that Homeopathy promotes the interdisciplinarity, helping the stakeholders to build the dialectical bases for changing agriculture paradigm towards sustainability and awareness of nature. The ontological bases of Homeopathy helped the stakeholders to promote a form of agriculture as a way of life, contributing to social development as well as maintaining diverse ecosystems.

The results also reveals that the method provide a salutogenic promotion in agriculture, offering a counter position of today's highly remediation approach to agriculture. In that sense, for the interviewees, health and vitality have different meanings, even though not disconnected. Homeopathy is not targeted to act against the organisms, but rather to bring it to its homeostasis back through a response of the plants and system itself.

Addressing the research questions on how a deeper understanding of Homeopathy could help farming and research, the interviews clustered pragmatic management information, which at the moment is utterly needed to support the agrohomeopathy data base, literature and discussion. It was possible to identify management strategies regarding the use of dynamized high dilutions in the field and research; to comprehend and categorize DHDs selection and to identify knowledge gaps that could be addressed for further research. This is a massive contribution to the development of any scientific subject.

This research supports the call for human values in agriculture, where the collaboration between farmers and scientists in the field of technological innovation and

perception of its benefits - in this case Homeopathy to promoting vitality in agriculture – stimulating decentralization of knowledge, enhancing informal modes of experimentation and externalization of tacit knowledge.

6.3. Why discuss vitality in agriculture is important to society?

This section starts recollecting a piece of information collected via the survey in which farmers declared that their perception of vitality was also perceived on the community dynamic. At first, I couldn't understand, but after contrasting my data with literature and interviews I was able to comprehend that the community interactions, based on experience, knowledge and services create a certain kind of bond, one that dialogue with genuine interesting for the parts involved leading to sense of value for both parts.

Researchers sometimes focus on just one of the natural factors which can affect harvest yields when in reality these natural factors change from place to place and from year to year. Vitality indicators in agriculture as assessed in this research, would help society to see food in a different way, not as a commodity but as a resource for humanity. The research showed that health and vitality are not understood as the same, being health as a consequence of the vitality.

This research showed that vitality would be reflected in plant growth and development - as seen in the results yielded from the systematic review and experiments - but also in the taste, feelings, biodiversity and perceptions that sometimes cannot be expressed with words or numbers - as the survey and interviews demonstrated. There is now, the possibility to explore further this data, including other analytic perspectives of information system, such as fuzzy logic (ZADEH, 1965).

The use of Homeopathy and dynamized high dilutions in agriculture could bring benefits to society in terms of increasing food production free of pesticide residuals – as in the case of the strawberry culture – enhancing the maintenance of biodiversity, valuing traditional and local knowledge towards the integration of the ecosystem and society.

When combining natural and social sciences, it was possible to realise that technical training cannot exclusively be focused on instrumentalization but must also consider the contexts of different cultural realities. The attitudes of farmers, advisors, and researchers in relation to the phenomena of vitality and the use of homeopathic preparations are related to with their attitudes towards nature; to ideas expressed and to

their values. The research results suggests that the homeopathic approach is one that is utterly needed in today's agriculture. It understands the Earth as part of humankind and not subject to its will. This point of view could potentially help society treat the ecosystem and all it involves in a much more personal and respectful way, because what we respect, we take good care of.

6.4. Conclusion

After reflecting on the whole research journey and, analysing the results, this research argues that using Homeopathy and dynamized high dilutions (DHDs) in agroecosystems provides a new position towards ontological and pedagogical perspectives in agriculture teaching and research. Education on vitality could be seen as having the function of humanizing man is the conscious action one must take to transform the world. Due to its holistic nature, Homeopathy creates the space for dialogue, and dialogue is an authentic form of pedagogy, one that integrates different forms of knowledge, combining them and creating what transdisciplinarity aims for…a new form of knowing that could be used for different subjects simultaneously.

From the authors perspective, the greatest contribution of the vitality in the agroecosystem is to revisit the primordial values and interactions of humans within the cultural development of agriculture, turning its impulse of development based on values that aligned collective welfare and societal development. Perceiving vitality in agriculture make us to question what our relationship to the earth is and, what it means for our human existence and evolution.

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APPENDICES A – LINKS FOR SOCIAL MEDIA GROUPS

Group Name	Links for the Groups
Biodynamic gardening (UK)	https://www.facebook.com/groups/biodynamicgardeninguk/
Agrohomeopathy homeopathy for farming and garden (UK)	https://www.facebook.com/groups/143714655807583/
Homeopathy in the garden (USA)	https://www.facebook.com/groups/homeopathicgardening/
Biodynamic Agriculture Brazil (BR)	https://www.facebook.com/groups/624852337545267/
Homeopatia (ITA)	https://www.facebook.com/groups/238808446790201/
IHA – Agrohomeopathy and Veterinary homeopathy (IND)	https://www.facebook.com/groups/1610793739224243/
Homeopatia internationala (ITA)	https://www.facebook.com/groups/197589510265290/
Secular Energetic Biodynamics (GER)	https://www.facebook.com/groups/213999672018859/
Homeopathy and Homeopaths (IND)	https://www.facebook.com/groups/myhomeopathy/
Homeopatia na Agroecologia (BR)	https://www.facebook.com/groups/902750269805910/
Homeopatia veterinária (BR)	https://www.facebook.com/groups/258635987547756/
Remedios Naturales Comenius (MEX)	https://www.facebook.com/groups/139695479713748/
Biodynamic Gardening Group (UK)	https://www.facebook.com/groups/biodynamicgardeningbrisbane/
Biodynamic Community (GER)	https://www.facebook.com/groups/biodynamic.community/

Homeopathy	**https://www.facebook.com/groups/477107369142968/ /**
Agricultura Biodinâmica (BR)	**https://www.facebook.com/groups/500629816806025/**
Homeopathy (IND)	**https://www.facebook.com/groups/153986248544918/**
Biodynamic and Beekeeping (UK)	**https://www.facebook.com/groups/289308751416755/**
https://www.facebook.com/groups/Homeoclinic/ (GER)	**https://www.facebook.com/groups/Homeoclinic/**
Homeopathy 360 (USA)	**https://www.facebook.com/groups/homeopathy360/**

APPENDICES B – QUESTIONS USED IN THE WEB-SURVEY

Please tick:

I confirm that I have understood the above study (as explained by the researcher in the written information provided).

I understand that my participation is voluntary.

1) **Is your farm:**

Certified organic
Certified biodynamic
Uncertified organic or biodynamic
Defra Countryside Stewardship
LEAF Marque
Permaculture
Agroecological
Non-chemical farming
Regenerative

2) **Rank in terms of importance the reasons why you farm this way? Where 1 is the most important 6 is the least important. Please don't select more than 1 answer per row:**

Spirituality

Profitability
Health
Family Tradition
Environmental Friendly
Social Impact

3) **How long have you been using homeopathy and dynamized high dilutions?**

0 – 3 Years
4 – 10 Years
10 + Years

4) **From where do you source the dynamized high dilutions?**

I make them on-farm
I buy them from homeopathic pharmacies
I buy them from a homeopathic specialist and administer them myself
I buy them from a homeopathic specialist who also administers them
I buy them from elsewhere

5) **Regarding the use of homeopathy on your farm: what do you use homeopathic remedies on?**

Commercial crops
Commercial livestock
Humans
Pets
Soil
Water
Garden crops

6) **Please, describe the most common DHDs used by you as well as their frequency of use and potency:**

7) **Do you use any of these other subtle approaches on your farm?**

Schussler salts
Plant essences
Substrate enriched with homeopathic remedy
Nosodes
Radionics

8) **Regarding the uses of the biodynamic preparations: which ones do you use?**

Spray preparation - horn manure (P500)
Spray preparation - horn silica (P501)
Spray preparation - Equisetum
Compost preparation - Yarrow (P502)
Compost preparation - Chamomile (503)
Compost preparation - Nettle (504)
Compost preparation - Oak Bark (505)
Compost preparation - Dandelion (506)
Compost preparation - Valerian (507)
Three Kings preparation
Barrel preparation
None of the above
Other

9) External technical advice regarding the use of homeopathy and dynamized high dilutions comes from:

Certification company
Private company advisor
University/ research advisor
Other farmer
Internet
Book or publication
Veterinary advisor
I don't use external advise as I learned from my family/upbringing

10) What are the main benefits you have experienced when using homeopathy and dynamized high dilutions methods?

Improved human health
Improved crop health
Improved livestock health
Improved ecosystem health
Reduced production costs
Higher yields/production
Tool in the management of transition of cultivation systems
Other, please describe:

11) **How do you perceive vitality on your farm? Explain in your words:**

12) **Finally, would you like to consider one of the follow-up options?**

Participate as a research case study (and optionally receive free labour from the researcher for one week).
Undertake a more in-depth, 45 minute virtual interview
Be notified when the research results are published
None of the above, thank you

APPENDICES C – QUESTIONS USED IN THE INTERVIEWS

1) **What is your background and why did you choose to work with homeopathy and DHDs?**

2) **Is it possible to different professional backgrounds to work and apply homeopathy in agriculture?**

3) **What are the benefits and challenges of using homeopathy and dynamized high dilutions in agriculture?**

4) **How do you select DHDs and potency?**

5) **How do you decide which potency to use and what is the mode of application of DHDs**

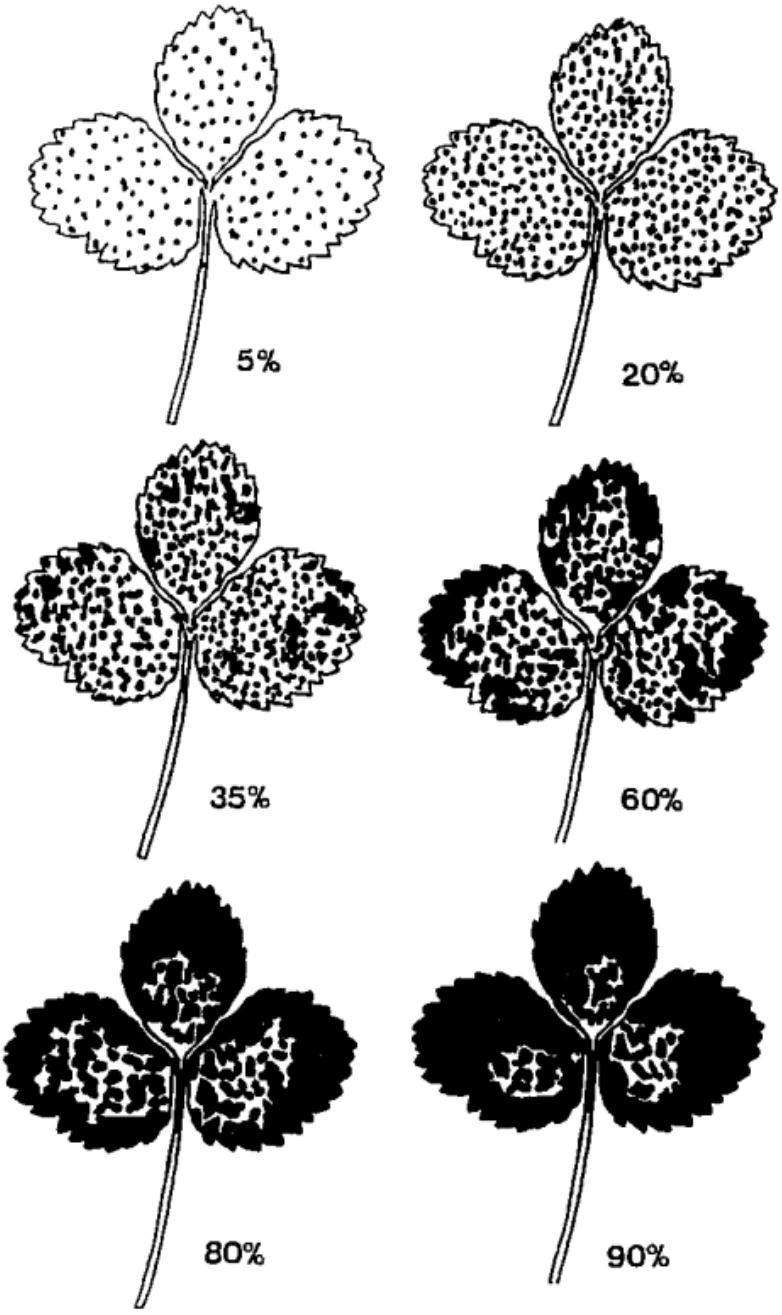
6) **What are your impressions about the use of nosode?**

7) **Regarding the connections between the use of homeopathy and dynamized high dilutions, and vitality: How do you measure and perceive vitality in the agroecosystem?**

8) **In your opinion, health and vitality are similar?**
9) **Open questions**

APPENDICES D – DIAGRAMATIC SCALLES

- *Mycospaerella fragariae (Tul) Lindau.* BRUGNARA et al., 2014



- Spider mite (*Tetranycus urticae Koch*) - PIROVANI et al., 2015:

10 – 20 adult mites/mid-tier leaflet: 5% - 30%

20 – 30 adult mites/mid-tier leaflet: 30% - 60%

30 – 40 adult mites/mid-tier leaflet: 60% - 90%

APPENDICES E – TOTAL PRODUCTION OF INDUSTRY AND FRESH MARKET FRUIT TOGEHTHER (g/treatment):

- **2019**

Kali 12CH	1193, 26
Sulp 12CH	1176, 57
Phos 12CH	1108, 22
Merc 12CH	906,25
Natu 12CH	819,48
Calc 12CH	823,53
Sili 12CH	763,87
HD 12CH	742,70
Control	808,90

- **2021**

Kali 12CH	948,77
Sulp 12CH	1237,76
Phos 12CH	873,96
Merc 12CH	656,21
Natu 12CH	534,39
Calc 12CH	617,93
Sili 12CH	763,87
HD 12CH	385,79
Control	293,48