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Preface

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1.4 Effects of Biodynamic Preparations: A Network Meta-Analysis

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Abstract

Biodynamic (BD) preparations are central elements of biodynamic farming, yet their agronomic efficacy remains debated. To address this, we conducted a meta-analysis of field trials evaluating the yield response to BD preparations. Based on a systematic search strategy, we compiled data from 54 field trials reported in 36 independent studies across nine countries and four continents, spanning from 1977 to 2023. All analyses were conducted on the natural logarithmic scale and followed a random-effects model weighted by the inverse of the squared standard error. Our results indicate a significant yield increase under BD treatment compared to untreated controls (mean effect: +3.7%, 95% CI: 1.6–5.8%, $p = 0.0009$).

Background and Aims

The biodynamic preparations are a core feature of biodynamic management and distinguish this method from other organic farming approaches. Scientifically spoken, the preparations are intended to support plant health and plant growth on a systemic level. As the rationale of the preparations is rooted in Anthroposophy and contains a lot of hypotheses that lack scientific validation until now, there has been much debate about this practice. Scientific results on preparation effects are heterogenous, leading authors to different conclusions. However, a sophisticated meta study has not been conducted until now. We fill this gap and present results from a meta analysis of published peer-reviewed articles on preparation effects on plant and soil properties.

Methods

The dataset builds on a previous compilation by Alain Morau (unpublished) and includes only peer-reviewed publications and doctoral dissertations. We expanded the literature search to include studies through August 2023 using Web of Science, Google Scholar, and regional databases. To ensure consistency and data reliability, only those trials that fulfilled defined inclusion criteria regarding treatment composition, experimental design, data accessibility, publication status, availability of yield data, and temporal scope were considered eligible for this meta-analysis.

We limited our search to studies published from 1980 onwards 2023 August. This cut-off point was chosen to reflect changes in agricultural practices, the standardisation of BD treatment protocols, and improvements in experimental design over time. Although this approach ensures relevance to modern conditions, earlier trials that could have provided additional historical context may be excluded.

We examined the data set using a factorial ANOVA framework (Piepho et al. 2012). All analyses were performed on the natural log scale (Hedges et al. 1999), and we applied a random-effects model that weights each observation by the inverse of its squared standard error.

Results and Discussion

A total of 54 trials (from 36 independent studies) were conducted across 3 of the 4 major climatic zones and on 4 of the 7 continents, spanning 9 countries. The experiments ran from 1977 to the present, with individual trial durations ranging from 1 to 28 years (mean = 3.9 years; median = 1.5 years).

At the writing of this article we did only finalize the evaluation of preparation effects on crop yields. However, other effects will be presented in detail at the conference and in the intended publication.

Crop yields were slightly (aprox. 4%) but significantly ($p<0.05$) improved by the application of the biodynamic preparations.

Interpreting the effect, it must be considered that a bias may arise from the fact that we expect the preparations to regulate plant health and growth in a most beneficial way. This regulation must not always result in an increase of yields, but could also decrease yields under certain circumstances, when the environmental conditions or individual properties of the plants rather require a moderation of processes. However, we did not find a valid way to test this hypothesis in our meta study.

Another drawback is that we could not include studies on preparation effects on the microbiome (Milke et al. 2023). Microbiome effects may be a key to the comprehension of the preparations, as they provide a link between the anthroposophical rationale and possible scientific explanations of an impact of the preps. Unfortunately, there are too few studies for a meta analysis of this pathway until now – this must be left to future research.

Conclusions

In our very robust meta analysis we observed a significant positive effect of the biodynamic preparations on crop yields. Even though the effect size was small, it is a clear proof of the existence of a preparation effect according to the expectation. This justifies further research in the biodynamic preparations, which is a very interesting challenge from a scientific point of view.

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1.5 Microbial functional diversity indicators in vineyard soils under biodynamic land management

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Abstract

An on-vineyard research project was conducted to assess the effect of biodynamic preparations (BD) on microbial functional diversity (MSIR) and extracellular polymeric substances (EPS).

The results showed that vineyards with BD improved soil quality, with higher soil organic carbon, nitrogen, and microbial biomass carbon levels. The MSIR approach clearly separated the treatments without and with BD. The study also revealed that the BD increased the production of EPS, which is a key component of soil structure. Particularly, the increase in EPS-carbohydrates production in vineyards with BD was linked to improved soil chemical and biological properties.

Background and Aims

Previous studies explain the essential role of soil microbial functions in nutrient cycling and decomposition (Op De Beeck et al. 2021; Rodas-Gaitan et al. 2022), emphasizing their importance for maintaining soil quality in biodynamic agricultural systems (Fritz et al. 2021; Milke et al. 2024). The quality of organic matter influences the microbial community's ability to produce "binding agents" such as extracellular polymeric substances (EPS) and glomalin-related soil protein (GRSP), which enhance soil structure and water retention, benefiting plant performance, especially under stress (Flemming et al. 2017; Costa et al. 2018; Ilyas et al. 2020; Benard et al. 2023).

The on-farm research project aimed to analyze the effects of biodynamic preparations (BD) on the functional diversity of microorganisms and the production of EPS and GRSP in the soils of four vineyards (Prissé, Fleurie, Lavernette, Prés Culey) in the Burgundian region of France.

Methods

This study was carried out in vineyard soils from the Burgundian region, and four farmers who owned about 0.5 ha were selected randomly. Each vineyard was divided into two halves, spraying annually in one half BD preparations (BD+), whereas the other half received no BD preparations (BD-).

Soil samples from each treatment (BD- and BD+) were collected to measure factors that reflect soil quality, such as soil organic carbon (SOC), total nitrogen (N), microbial biomass carbon (MBC), multi substrate-induced respiration (MSIR), with 17 substrates and H_2O, EPS, and GRSP (Sradnick et al. 2013; Bublitz et al. 2023).

Results and Discussion

Our study demonstrates that the application of BD preparations has a positive impact on soil, leading to significant increases in SOC, total N, MBC, basal respiration, and the MBC/SOC ratio. The discriminant function (DF) analysis revealed that the differences between BD- and BD+ treatments were most pronounced at certain vineyard sites, where DF1 separated the two treatments at Prés Culey and Lavernette, and the DF2 separated them at Prissé, Fleurie, and Prés Culey.

Our research confirms the positive effects of BD preparations on soil respiration (Multi-SIR), which have been observed in previous long-term field experiments (Fritz et al. 2020; Rodas-Gaitan et al. 2022). A possible explanation for these benefits is that BD preparations contain bioactive substances that can trigger strong respiratory responses and promote microbial functions in the soil (Milke et al. 2024). These bioactive substances, present in trace amounts, may be responsible for the observed improvements in soil health.

Conclusions

Our findings indicate that the increase in EPS-carbohydrate content in BD+ is positively correlated with enhanced respiratory activity, suggesting a synergistic interaction between these substances and the improvement of soil chemical and biological properties in vineyards. Conversely, lower ratios of EPS-carbohydrates/MBC and EPS-proteins/MBC after BD application suggest that soil microorganisms are able to allocate more resources towards the production of microbial biomass, rather than diverting them towards the synthesis of these extracellular polymers.

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2.2 Biodynamic Ecology as Therapeutic Education: Nurturing Growth and Transformation

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Abstract

Recent research on the history of biodynamic practice in the UK has identified seven key domains where biodynamic practices are currently predominant, including biodynamic ecology in therapeutic education. (Reakes, 2024) At Ruskin Mill Trust, biodynamic farms serve as central learning environments for students with special educational needs (SEN), where trained educators integrate biodynamic principles into their teaching.

Research conducted at Coventry University's Centre for Agroecology, Water and Resilience, and at Ruskin Mill Trust, highlights how SEN learners experience personal growth through engagement with biodynamic ecology. This is reflected in qualitative testimonies and outcome space analysis from both SEN learners and staff. A master's module on biodynamic ecology was developed to train educational leaders, revealing a transformative impact on their understanding of pedagogy and purpose.

Key themes emerging from the research include Transformation Through Nature Connection, Transdisciplinary Integration, Threshold Concepts in Embodied and Situated Learning, and Holistic Nutrition as a Mediator of Culture. All these themes can contribute to behavioural change, improved well-being, advancement of skills, and agency. The study suggests that biodynamic ecology fosters relational ontologies, allowing learners to reimagine their potential beyond societal limitations. This educational model presents a unique approach that integrates cognitive, social, and cultural development through engagement with biodynamic agroecological practices on the land and in the wider cultural life

Background and Aims

Berni Courts has been involved for the past 30 years in developing the field of biodynamic ecology as educational practice within Ruskin Mill Trust, working alongside colleagues. The research aims to offer a critical analysis of this educational method, positioning it as an effective educational practice with biodynamic agroecology at its core.

The study incorporates perspectives from SEN learners who experience biodynamic farms and gardens as part of their education, as well as staff who have completed the "Growing the Land; Growing People" biodynamic training program that enables them to work biodynamically with

SEND learners. The final dataset is collected from senior college and school leaders who implement farms and gardens as learning environments, which are crucial to Practical Skills Therapeutic Education (PSTE).

Methods

This research utilised a mixed-qualitative methodology, primarily using phenomenography and its concept of "outcome spaces" (Marton, 1981; Akerlind, 2022) to capture participants' experiences of self-orientation, engagement, and personal change. Data was gathered via semi-structured interviews designed for SEN learners with communication challenges (Diefenbach, 2008; Mahuri et al., 2022), and a taxonomic filter was employed to identify growth points for both learners and staff who held a diploma in biodynamic ecology.

Acknowledging a 30 -year "insider" position, this study adopts a critical autoethnographic perspective to lend credibility (Castagno, 2012) and uses action research principles to validate internal research (Brannick & Coghlan, 2005; McNiff, 2013). While ensuring anonymity, the research is enriched by narrative case studies (Connelly & Clandinin, 1990; Nasheeda, 2019).

As part of the research, the author developed and taught a Master's module on biodynamic ecology to 16 educational leaders. A Reflexive Thematic Analysis (RTA) of their final submissions confirmed the efficacy of this knowledge for leaders in the field (Braun & Clarke, 2021).

Results and Discussion

The culture of biodynamic ecology enables SEN learners to experience a profound transformation, fostering growth in their physical, cognitive, emotional, and social capacities. This journey serves as a vital developmental stage, comparable to higher education for their “neurotypical” peers and can inspire them to use their newfound competencies in wider society. This transformative potential extends to staff, with training in biodynamic agroecology renewing their sense of purpose as therapeutic educators; notably, a significant percentage of biodynamic practitioners at Ruskin Mill Trust are graduates of this training. A Relational Thematic Analysis of educators' work confirmed a significant evolution in their pedagogical understanding, revealing new ways to predict and change behaviour (Mena-Garcia et al, 2019; Pirchio et al, 2021; Morrigi et al, 2020). This entire framework is supported by a holistic nutritional approach where the sensory-rich farm environment, social interactions, and consumption of homegrown food cultivate a culture of health, belonging, and growth (Franco et al., 2017; Cekici & Sanlier, 2017; Monterossa et al, 2020).

A central theme from the Master’s submissions is the encounter with "relational ontologies": an educational paradigm in biodynamic agriculture with profound potential for wellbeing (Riley et al., 2024).

In biodynamic ecology, different disciplines converge towards a state of holism, informing one another to create a new "onto-epistemology" (Hyde, 2021) one that is fundamentally ethical

(Lange, 2018). This method may uniquely free our cognitive processes, actions, and social outcomes from the constraints of what the world is, and what it expects us to be (Ceder, 2020).

This aligns with the Ruskin Mill Trust's principle of "re-imagining potential." Many of our learners have experienced educational failure. However, biodynamic ecology within PSTE offers them a new worldview, empowering them to envision a self beyond the limited expectations of the wider world.

Conclusions

An interlocution emerges between the three study groups, where staff and leaders are required to understand and meet the needs of SEN learners. In doing so, SEN learners are likely to find an entry point to relationality and can advocate for their own growth, particularly in their wellbeing and social capacities.

The "Growing People" aspect of the "Growing the Land; Growing People" biodynamic training speaks strongly to teacher understanding of dysconscious ableism and challenges this through the design and understanding of land-based activities (Broderick & Lalvani, 2017). The nature of biodynamic agroecology is that it aims to be non-exploitative of the land and its farm inhabitants, including non-human beings, and promotes pro-environmental behaviour. It is labour-intensive and often small-scale, requiring mostly hand tools and physical endeavour.

In an educational context, the land and the learner meet within a meaningful framework for respectful relationships at a very human level.

There is an interlocution that comes into being between the three study groups, where the staff and leaders are required to understand and meet the needs of the SEN learners, and in doing this, the SEN learners are likely to find an entry point to relationality. They can vouch for their own growth points especially in their wellbeing and social capacities. The Growing People aspect of the Growing the Land Growing People biodynamic training speaks strongly to teacher understanding of dysconscious ableism and challenges this in the design and understanding of activities on the land. (Broderick & Lalvani 2017) The nature of biodynamic agriculture is that it aims to be non-exploitative of the land and its farm inhabitants, including the non-human, and promotes pro -environmental behaviour. It is labour intensive, often small scale, so mostly requires hand tools and physical endeavour. In an educational context the land and the learner are meeting a meaningful context for respectful relationships at a very human level.

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3.3 Price building in associative food value chains

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Abstract

Fair pricing is a crucial issue in agricultural markets, including biodynamic agriculture. Rudolf Steiner emphasized the importance of fair prices in his concept of associative economics. Based on the existing literature, research perspectives on prices in associative agricultural value chains are discussed. Better prices are understood both as motivational factor for participation in associative value chains and as the result of such participation. Moreover, although price is a fundamental element of associative value chains, their role in other aspects of interorganisational fairness is also highlighted.

Background and Aims

“Most of the food- and agriculture-related SDG targets are still far from being achieved” (FAO, 2023). This statement summarizes not only the status of the SDGs in the area of food and agriculture, but is also indicative of the state of our entire agricultural and food system. A radical change in the agricultural and food system is seen as one of the most important challenges of our time, the success of which is of great importance for the development of society as a whole (Fischedick et al., 2024). Rudolf Steiner also sees the special role of the agricultural sector in the process of striving towards social justice (Steiner, 1919, 1924). In his understanding, also known as Steinerian or associative economy, members of the value chain join together in associations to share information and make collective decisions based on the resulting transparency. Since Steiner (1922) described prices as the most important aspect of economic activities and the achievement of fair prices is widely discussed, the aim of this paper is to present the current state of research on prices in associative agricultural value chains. Since Rudolf Steiner gave eight lectures for farmers in 1924, which were the basis for the biodynamic approach (Brock et al., 2019) the research potential in biodynamic agriculture is also discussed.

Methods

In order to select the literature as replicable as possible, a systematic approach was used for selecting the literature (Sauer & Seuring, 2023). The process used is shown in Figure 1.

The search string (Figure 2) was derived from a literature review and a semi-automatic keyword extraction (Grames et al., 2019) and combined with a search string for agriculture (Luo et al., 2018) and supply/ value chain (Jose & Shanmugam, 2020) as well as the keyword “pric*” using the operator “AND”. The publications were found via Web of Science (WoS).

Results and Discussion

A description of the articles analysed (Seuring & Gold, 2012) is provided in Table 1.

It is noticeable that higher prices are considered to be a motivation and advantage for farmers in voluntary certification schemes (Furumo et al., 2020, Nupueng et al., 2022, Phranakhone & Nanseki, 2015), multi-stakeholder associations (Guyver & MacCarthy, 2011) and as a factor influencing the choice of the marketing channel (Mensah-Bonsu et al., 2019). Farmers’ associations can contribute to higher minimal prices by facilitating access to government funding (Wulandri et al., 2020), while multi-stakeholder initiatives offer lower input prices (Nupueng et al., 2022). Farmers in food consumption cooperatives receive prices that cover production costs and guarantee fair wages, ensuring affordable consumer prices (Sacchi et al., 2021). Interbranch Organizations can facilitate negotiations on a reference price between producers and processors through economic analysis, market research and statistical evaluations, but they have no direct influence on transactions (Samoggia et al., 2022).

Trust is also seen to be an important factor in alternative food networks, both from the perspective of producers and consumers (Sacchi et al., 2021, Slavuj Borčić, 2020). Interestingly, Nupueng et al. (2020) conclude that trust is more important for non-RSPO-certified farmers than for certified farmers, as formal contracts offer the latter more security.

An asymmetrical distribution of power manifests itself in the ability to unilaterally determine prices vis-à-vis other actors (Javornicky et al., 2021). Cooperatives that negotiate collectively through cooperative associations have greater bargaining power vis-à-vis retailers and thus greater influence over prices than if they negotiate separately (Xi et al., 2025).

Transparency is described as a constitutional principle of alternative agricultural and food networks (Sacchi et al., 2021) and as a strength from the consumer perspective (Doernberg et al., 2016). Access to relevant market-related information is also an important factor for farmers when choosing a marketing channel (Mensah-Bonsu et al., 2019) and governance structure (Sharma et al., 2023).

The aspects – financial outcomes, trust, power and transparency – are all factors that can be found in the interorganisational fairness framework presented by Gudbrandsdottir et al. (2021). In addition, vertical and horizontal supply chain coordination are described here as a strategy for overcoming challenges in food supply chains.

As Brock et al. (2019) and Santoni et al. (2022) note, research on the socioeconomic perspectives of biodynamic agriculture is limited. It is therefore not surprising that only one of the publications (Slavuj Borcic, 2020) mentions farming according to biodynamic principles as a characteristic of the farmers. None of the studies analysed explicitly used a price transmission framework. Further research is needed here, as vertical price relations are particularly suitable for showing the distribution of costs and profits in the value chain (Cramon-Taubadel, 2021, Hillen, 2021).

Conclusions

The necessity of forming associations, as described by Rudolf Steiner (1922), is also discussed and practiced outside of biodynamic agriculture. In particular, forms that involve members of the value chain vertically and horizontally could contribute to greater fairness between organisations within value chains and, in particular, to higher producer prices. As the concept of associative economy is an integral part of biodynamic agriculture, biodynamic value chains could make a special contribution to fairer prices and greater interorganizational fairness.

Table 1: Description of articles analyzed (Source: Own data)

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3.4 Development-oriented recognition procedures as an alternative to infringement-oriented controls?

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Abstract

The applicability of a development-oriented recognition procedure for production according to standards in the agriculture and food sector as an alternative to infringement-oriented controls was examined. A procedure that has been developed and trialed as a pilot project by Demeter Germany was evaluated. In a participatory process evaluation indicators were developed. The analysis of procedure acceptance among consumers was carried out with an online survey of a representative sample (n=1.058).

Testing and evaluation of the procedure show that the tested version of the recognition procedure can be used as an alternative to conventional organic association certification.

Background and Aims

Certification is based on risk-orientated examination of binding guidelines and certifies their compliance. This does not promote further development regarding ecological values or sustainable management.

Development-orientated procedures that consider the individual farm situation may be an alternative. A procedure developed by Demeter Germany was evaluated for its suitability to promote farm development and initiate high-quality quality development.

Methods

Two workshops were held in 2021, each lasting around two hours, with a total of 16 participants. Using the SMART scheme four evaluation indicators were drawn up in the workshops and 7 further indicators were subsequently (further) developed by the project team based on interviews with stakeholders. Additionally, an online survey was conducted with a representative sample (n=1.058).

Results and Discussion

The recognition procedure fulfils its set objectives of 'initiating or promoting further development on the participating farms' and creating a space for recognition and appreciation for producers. The farm development goals are partially achieved, but often not within the planned timeframe.

The number of non-conformities identified in 2023 compared to the preliminary inspection before joining the project almost doubled. Considering the type and the low number of serious non-conformities identified, a moderately higher risk can be assumed compared to the current certification procedure.

Acceptance on the part of various stakeholders (participants, consumers) is high, and the feasibility and usefulness of the procedure is given after analysing the indicators. However, there are still open points for discussion in terms of feasibility.

Conclusions

Testing and evaluation show that the tested version of the recognition procedure can be used as an alternative to conventional organic association certification for farms. Existing challenges must be resolved.

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3.5 Sustainability and Economic Viability of Olive Farming Systems: A Comparative Study in Sinai, Egypt

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Abstract

This study conducts a holistic sustainability assessment and evaluates the economic viability of olive production systems in Egypt's Sinai Peninsula by comparing conventional, organic, and biodynamic farming systems. The research employs the SAFA framework, True Cost Accounting (TCA), and Cost-Benefit Analysis (CBA) to identify synergies and trade-offs across environmental, economic, and social dimensions of sustainability. Nine farms representing three farming systems (three farms per system) cultivating Picual olive variety were selected east of the Suez Canal. Each farm covers 20 feddans under uniform pedoclimatic conditions. The study aims to determine which farming system is most suitable for the Egyptian context, providing evidence-based insights for farmers, policymakers, and stakeholders to improve policy interventions in Egypt's olive sector.

Background and Aims

Egypt faces severe economic challenges including foreign currency shortages and heavy import reliance, prompting government strategies to boost exports by 15-20% and achieve $145 billion in export revenue by 2030 (Albazar, 2024; Ben Fishman, 2024). Egypt's olive production has grown significantly, reaching 1.13 million tons from 269 thousand feddans in 2021/22, compared to 1.08 million tons from 214 thousand feddans in 2017/18 (Awad & Nagaty, 2024). While organic farming prioritizes soil health and environmental sustainability, biodynamic systems introduce holistic approaches with unique practices. However, limited research exists comparing economic and environmental trade-offs of conventional, organic, and biodynamic systems under Egypt's economic realities. This study aims to fill this gap by providing evidence-based insights aligning with Egypt's Vision 2030 goals and contributing to SDG 12 (Responsible Consumption and Production).

Methods

This study adopts a mixed-methods approach combining qualitative and quantitative analyses. Nine farms were selected east of the Suez Canal in western Sinai Peninsula, with three farms representing each system (conventional, organic, biodynamic). Each farm covers 20 feddans (8.4 ha) cultivating Picual olive variety under similar pedoclimatic conditions.

To evaluate sustainability and economic feasibility of the farming systems a quantitative and qualitative Analysis was combined. The SAFA framework evaluates sustainability across Environmental Integrity, Economic Resilience, and Social Well-being dimensions. Cost-Benefit Analysis (CBA) assesses direct financial indicators including production costs, revenues, and profitability and also incorporates the value of carbon credits as an additional benefit. True Cost Accounting (TCA) incorporates monetized externalities using the Cool Farm Tool (CFT) for greenhouse gas emissions, biodiversity, and water use assessments. Primary data collection involves surveys and interviews with farm owners and workers, while secondary data includes financial records and government reports. Data analysis employs descriptive statistics, correlation analysis, and sensitivity analysis. The data will be analyzed using sensitivity analysis, descriptive statistics and correlation analysis.

Results and Discussion

Conclusions

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4. Food and Nutrition

4.1 Biodynamic Farming and Nutritional Quality: Understanding Life Forces in Tomatoes

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Abstract

A century after Rudolf Steiner warned that synthetic fertilizers drain crop vitality, a 2024 ICAR survey now reports nutrient loss and toxin build-up in staple crops. To explore a remedy, we cultivated tomatoes (Solanum lycopersicum) on paired plots: one using Biodynamic (BD) practices with preparations BD500, BD501, and compost preparations 502–507; the other using conventional methods with chemical fertilizers and pesticides. The harvested fruits were analyzed using Gas Chromatography–Mass Spectrometry (GC-MS). BD fruits displayed coherent radial symmetry, absent in the controls, reflecting enhanced secondary metabolism. These findings echo ancient Tamil wisdom, *"giving good food is giving good life"*—and reaffirm Steiner's thesis: phasing out mineral fertilizers and adopting BD principles leads to nutrient-dense, toxin-free food imbued with measurable life forces, offering a credible path toward regenerative nutrition.

Background and Aims

The organic farming community has long advocated that organically grown food is richer in nutrients and lower in toxins compared to conventionally produced food. Numerous academic studies have supported this claim. In recent decades, the rise in chronic illnesses such as diabetes, high blood pressure, cancer, respiratory disorders, and premature births has drawn attention to the nutritional quality of food as a key factor in public health.

Biodynamic (BD) farming, which views the farm as a living organism and works with natural cosmic rhythms, is believed to enhance not only nutrient content but also impart vital "life forces" to food. While this belief is deeply rooted in traditional and holistic farming wisdom, it is essential to validate it through scientific analysis.

This research was undertaken to identify and quantify the nutritional and energetic differences between Biodynamically grown and conventionally grown tomatoes (Solanum lycopersicum). Through field cultivation and laboratory analysis, the study aims to provide concrete evidence on how BD farming contributes to human health, offering a sustainable alternative to chemically grown food.

Method of the Research Work

This research was designed to compare the nutritional quality and presence of life forces in tomatoes (Solanum lycopersicum) grown using Biodynamic (BD) and conventional methods. Biodynamic farming, rooted in a holistic view of agriculture, emphasizes the health of soil, plants, animals, and humans, aiming to produce nutrient-rich food in harmony with nature.

Field Trial: The cultivation was carried out on a one-acre plot (4000 m^2) in Trichy District, Tamil Nadu, South India. Tomato seeds were sown in September, with transplanting done in October—an ideal season for vegetable cultivation in the region. The land was prepared with five heaps of BD compost (5m x 1.5m x 1.5m), thoroughly incorporated through rotovating process. Plant beds and furrows were laid out with a spacing of one meter between rows, and an inline drip irrigation system (4 LPH, 50 cm spacing) was installed.

Following DEMETER standards, Biodynamic preparations including BD500, BD501, CPP, and compost preparations were applied sequentially. The crops remained healthy, requiring minimal plant protection—only a 5% Neem Kernel Solution, a 3G biopesticide (Ginger–Garlic–Green Chili), and 12 pheromone traps to prevent American Bollworm infestation.

Laboratory Analysis: Harvested fruits from both BD and conventionally grown plots were subjected to [1]**Gas Chromatography–Mass Spectrometry (GC-MS) analysis.** This advanced technique enabled profiling of key metabolites such as organic acids, sugars, amino acids, and lipophilic compounds. The results established the presence of richer secondary metabolites and "life forces" in BD tomatoes, demonstrating their nutritional superiority over conventionally grown counterparts.

Results and Discussion

From the above analysis, 12 different bio-compounds were identified in the biodynamically (BD) grown samples, whereas only 9 bio-compounds were found in the chemically fertilized (CF) samples. Furthermore, the CF samples may contain higher levels of toxins due to the use of chemical fertilizers and harmful agrochemicals. However, no pesticide residue tests were conducted in this study. It is strongly recommended that a comprehensive comparative analysis be carried out, including nutrients, life forces, and pesticide residues.

Table-1: GC-MS ANALYSIS OF BIODYNAMIC (BD) *SOLANUM LYCOPERSICUM* FRUIT EXTRACT-LIST OF COMPOUNDS

S. N0	COMPOUND	RETENTION TIME	AREA %	HEIGHT %
1	1-(3,4-DITRIMETHYLSILOXYPHENYL)-2-ISOPROPYLAMINOETHANOL	9.996	2.65	3.83
2	CYCLOHEXASILOXANE, DODECAMETHYL	13.923	8.16	10.5
3	2-CYCLOBUTEN-1-ONE, 4-[[(1,1-DIMETHYLETHYL) DIMETHYLSILYL] OXY]-2,3-DIMETHOXY-4-(3-PHENYL-1-PROPYNYL)-	17.538	2.13	3.37
4	DIISOOCTYL-PHTHALATE	34.855	69.14	59.97
5	(SS)- OR (RR)-2,3-HEXANEDIOL	35.806	1.31	1.43

6	3,4-DIHYDRO-4-(1,3-DIOXOLAN-2-YL)-5,7-DIMETHOXY-1(2H)-BENZOPYRAN-2-ONE	36.665	0.65	1.26
7	1,2-BIS[1,2,3-TRI(T-BUTYL)-2-CYCLOPROPEN-1-YL] 1,2-ETHANEDIONE	38.17	0.44	0.58
8	NICKEL (II)-BIS[2-(HEPTAFLUOROBUTANOYL) -(+) CHOLEST-4-EN-2-ONATE]- fungicide	38.425	2.33	1.48
9	(+-)-1-(ACETOXY)-2-(1-BROMOETHYL)-3-METHOXYANTHRAQUINONE	38.587	0.73	1.53
10	SILANE, [2-[(1,1-DIMETHYLETHYL) DIPHENYLSILYL] ETHENYL] TRIMETHYL-, (E)	38.67	1.63	1.54
11	TRI-O-TRIMETHYLSILYL, N-PENTAFLUOROPROPIONYL DERIVATIVE OF TERBUTALINE	38.608	2.85	1.43
12	4,5,6,6A,10',11'-HEXAHYDROSPIRO{5'H-DIBENZO[A,D]CYCLOHEPTENE-5',3(3AH) - [4,5,6] METHENOCYCLOPENTAPYRAZOLE}	40.165	1.5	0.51

Among the phytocompounds identified in BD Solanum lycopersicum, the following novel compounds with high pharmacological activity were discovered:

- Tri-o-trimethylsilyl, n-pentafluoro propionyl derivative of terbutaline, identified in the biodynamic sample in large quantities, acts as a bronchodilator and to delay premature labor.
- (+/-)-1-(acetoxy)-2-(1-bromoethyl)-3-methoxyanthraquinone, which exhibits anticancer activity, is present only in biodynamic Solanum lycopersicum fruit extract.
- Ethanedione, bis[4-(1,1-dimethylethyl) phenyl], has shown promising results as a potential drug candidate for the treatment of various diseases, such as cancer and diabetes.

Conclusions

This study concludes that biodynamically grown tomatoes (Solanum lycopersicum) are rich in secondary metabolites known for their beneficial effects on human health, including protection against cancer, diabetes, respiratory disorders, and premature birth. Consuming such nutrient-dense, toxin-free food supports overall well-being. Biodynamic farming also enhances soil health, contributing to sustainable agriculture and environmental resilience. Thus, producing and consuming BD food aligns with the UN Sustainable Development Goals—SDG 2 (Zero Hunger), SDG 3 (Good Health and Well-being), and SDG 12 (Responsible Consumption and Production). Further research is needed to isolate and explore the economic potential of these bioactive compounds.

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5.6 Scientific guidelines for preclinical research on potentised preparations: Benefits for Biodynamic Research

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Abstract

Designing good experiments for basic research is a challenge, especially when subtile effects on living organisms are investigated like in biodynamic research. In the field of complementary and integrative medicine, scientific guidelines for preclinical research on potentised substances (PrePoP guidelines) have been published. As an example of how these research guidelines can be applied in BD research, we present our research project which investigates possible influences of BD preparations (500P and 501) administered at a specific cosmic constellation (the opposition of Moon and Mars, MoM) on oak seedlings. The design of our research project was supported by the transdisciplinary application of the recommendations and considerations collected in the scientific PrePoP guidelines especially regarding controls, blinding and randomization.

Background and Aims

Designing good and methodological reliable experiments for basic research is a challenge. This is particularly true for biodynamic (BD) research examining subtle effects on living organisms. Various aspects have to be considered, like controls and the question of outcome parameters. Recently, scientific guidelines have been published for preclinical research on potentised preparations (PrePoP guidelines) in the field of complementary and integrative medicine (Tournier et al. 2024). They cover additional aspects of the design of experiments and aim to provide recommendations for high-quality, statistically sound, and reproducible research. Our contribution will shed light on different aspects of applying the PrePoP guidelines to the design of a specific BD research experiment.

Methods

As an example of how the PrePoP guidelines can be applied in BD research, we present our research project, which investigates possible influences of BD preparations and cosmic constellations. EIn particular, in this project we intend to study possible effects of BD preparations (500P and 501) administered at a specific cosmic constellation (the opposition of Moon and Mars, MoM) on oak seedlings. For the experiment design, we had to determine several parameters (e.g. origin and vitality of acorns as starting plant material, amount of plants in each treatment group, appropriate controls, time and way of applying the BD preparations etc). We also had to take additional influencing factors into account (e.g. season, weather and laboratory conditions during the evaluation phase). In order not to miss important items in designing the experiment, it was useful to check items which are summarized in the checklist published in the PrePoP guidelines. Any items that were not suitable for our research question were discarded.

Results and Discussion

For us it was meaningful to consider some of the recommendations and considerations suggested in the PrePoP guidelines when designing the new research project focussing on possible effects of BD preparations administered at a specific cosmic constellation (MoM). Since the project involved two locations with pots in the garden and a field trial, we had to determine how many replications of each treatment respectively and controls should be included in each setting. The treatment consisted of applying the BD preparations (500P and 501) repeatedly (each 2-3 times/year) to germinating and growing oaks over a time frame of 6 years few hours before and after the selected constellation. During the last 3 years, the evaluation phase took place.

Water was applied as control for applying the BD preparations. We hypothesised that the constellation impulse could be given when exposing the trees to the preparations/water control few hours before the effective constellation time. Therefore, as a control for the constellation impulse we exposed the trees to BD preparations/water control at an equal time after the effective constellation. After 3 years the oaks unfolded sufficient amounts of leaves for two or three samplings per year in order to take the seasonal variations into account. Leaves of each variant were mixed and the samples were randomized and blinded for further assessment in the laboratory. Sample differences were evaluated by juice extraction from leaves of the young oak trees and further analysed by applying capillary dynamolysis and copper chloride crystallization.

Conclusions

The design of our research project, investigating possible effects of BD preparations administered at a specific cosmic constellation (MoM) was supported by applying the recommendations and considerations collected in the scientific PrePoP guidelines especially regarding controls, blinding and randomization. The data analysis of the biodynamic preparation and constellation experiment, designed by using the PrePoP guidelines, is ongoing.

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5.7 Qualitative Nature Research: Expanding the Scientific Framework for Organic Agriculture

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Prelude

What does a pig perceive from its environment? How does a chicken and a pig talk to each other? What does the tree perceive? What characters do lime trees have? What social structure do lime trees have? Do they have roles? How do the sheep and the tree talk to each other? What does the grass feel when it is trodden on by the cow? How does the earthworm react to the green cuttings above? What happens when the earthworm encounters a mole? How do mites play?

Need for new research methodology

In the natural sciences (NW) today, nature is primarily analyzed quantitatively and statistically. Theories are used to formulate hypotheses. The input is varied in experiments and the output is measured. The data collected in this way are statistically analyzed. The results are significances, correlations, effects, connections and functions. The view of nature is functional-mechanistic. Nature itself, i.e. living, social nature, is left out and is not considered. This is not a malicious intention, but a consequence of the quantitative methodology.

Starting points for qualitative-empirical nature research (QNF)

Studying nature as a living or social nature is the subject of the QNR (Timmermann 2024). It also takes up the scientific methodology that followed Goethe[2] , but at the same time offers a fundamentally open approach, which makes it possible to establish qualitative-empirical research styles for all natural science and related disciplines as a completely normal research option.

QNR draws on a successful and established model: qualitative-empirical social research (QSR). This recourse is interesting both in terms of the history of science and methodologically. In the 1960s, QSR developed out of research practice and in critical engagement with the dominant paradigm of quantitative social science (SS)3 (Strübing 2018). A wealth of different qualitative research styles emerged under the label "QSR" (Kleemann et al. 2009). Formal acceptance did not take place until 2002, when the German Sociological Association recommended "equal training in qualitative and quantitative methods as a standard for sociological degree programs" (Strübing 2018: 20). Recognition at eye level.

The basic thesis and demand of this article is: <u>Like the QSR in the social science, a QNR in the natural science should become standard.</u>

What is Qualitative Nature Research (QNR)?

Here we understand nature to mean everything living, from ants to walnut trees, to complexes derived from them, such as the soil, the forest, the landscape or the underwater world, and also human beings insofar as they are also nature through their bodies. The terms "living" or "social nature" are used synonymously here, because being alive also means being social and vice versa. At the same time, nature is a construct that has been changed in many ways by us and with us, it is "hybrid" (Latour 2008/1991) or "cyborg" (Haraway 1995). Nature is understood as the place that encompasses us, "where a subject encounters something in its existence as unavailable ("unverfügbar") (Böhme 1997: 13).

QNR is interested in nature itself, its vitality and its dynamics. Because nature acts, it communicates, it interacts, it has strategies and pursues structures of meaning. Three selected dimensions are used to characterize QNR.

Single case and everyday life

Nature also has its everyday life. And this is always different. The individual case or the individual or a specific group is special in each case. The individual case does not disappear in the mass of a sample, as is necessary in hypothesis-testing statistical methods (Strübing 2018). In QNR a theoretical dimension is always worked out more clearly through different or contrasting cases, in the context of everyday life. This is not a question of quantity.

Circular and open research process

The research process is open in qualitative research. The first field visit starts with a question. The question is not theory-free or without prior knowledge, but without fixed hypotheses to be tested. With this conceptual and empirical openness in the field, the object of research is explored. Data are diverse: observation protocols, videos, documentation, diaries, interviews. (Almost) anything is possible. For QNR researchers, creativity and curiosity are required, especially in terms of new methods. The data material is transcribed, i.e. textualized. These transcriptions are interpreted. Categories and dimensions are formed, "coding" takes place. The findings from this research phase are the starting point for the choice of method and the next field situation ("theoretical sampling"). We go back into the field and collect data. It is a circular process of collecting data, analyzing the data and selecting the next data collection situation. This circular process is repeated until "theoretical saturation" sets in and nothing new is discovered. The object of research is described more and more precisely and "thick" (Geertz 1987). A theory emerges from the data, an area-related theory, a grounded theory (Glaser & Strauss 1967; Strauss 1998).

Understanding – reconstructing

The transcripts need to be interpreted and understood. We are interested in the "qualitative moments" in the context of everyday life and a unique environment. Nature also reacts to this environment. It acts, and always somehow uniquely. It interprets its environment and reacts in some way. Like us humans, nature subjects can live modes of perception, judgements, relevance settings, supra-subjective, nature-society patterns of interpretation. And these make up the structures of meaning in their everyday lives (formulated analogously to social sciences: Kleemann & Matuschek 2009: 18). However, as constructions of "common sense" (Schütz 2004/1953), as first-degree constructions so to speak, these are not accessible for research. They are only accessible to the QNR researcher as "second-degree constructions

(Schütz 2004/1953: 159), i.e. only via a "methodologically guided external understanding", through special "conceptual-theoretical explications” (Kleemann & Matuschek 2009: S18f.).

This is because researchers interpret and construct what is not directly accessible to them. What applies to researching humans also applies to researching nature. Analogous to Schütz, we can initially state: Direct access will not be possible, but only the mediated understanding of others. It is not possible to talk to sheep, but to try to understand what sheep mean to say.

Research is language and conceptual work

Scientists are not philosophical theorists. They are practitioners. They use language, concepts and sentences to become active in their reality. The Pragmatism, for example, understands reality as the "result of people's active engagement with their material and social environment” (Strübing 2018: 50). Every action is bound to space, time and perspective, "so that, strictly speaking, no two actors experience exactly the same reality". The usual subject-object dualism dissolves and becomes a "continuum". An object is then "a practical constitutive achievement (Strübing 2018: 50). Reality is therefore not arbitrary, but a complex construction that can only be conceptualized approximately. The self-image of what we generally understand by data, what we expect from the role of researchers or what we understand by theory is shifting (vgl. Strübing 2018: 51 ff.).The meaning of language, practice and constituent environment has been wonderfully elaborated in the QSR and can be transferred to the QNR.

Research is practice

Good research is to be understood as good professional practice. A practice that is associated with many requirements. "Quality criteria of qualitative research" are, for example, the appropriateness of the subject matter, empirical saturation, theoretical penetration, originality and textual performance (Strübing 2018: 204ff.). These are all requirements that can be transferred to a QNR. How can the object of research be justified? Is the empirically obtained data material enough? Is the research question theoretically well understood? Is the field of research new and linguistically well understood? These are aspects that are linked to the competence of theoretical (self-) reflection.

The four requirements that are named for phenomenological research are also practical (Böhme 1994: 242; Timmermann 2007): methodical approach, learnability, contribution to intersubjective epistemic progress, communicability of its results. Practical scientific work aims at intersubjective, reliable findings. Communicability or textual performance are relevant here. How do I have to present my findings so that my readers can understand them? This textual performance is the "didactic part" - as Goethe calls his Theory of Colors in the subtitle (Goethe 1998: HA, Bd.13: 330ff) - of good qualitative research (Timmermann 2007).

The change of perspective alone is appealing: not to ask which functions, which control mechanisms we can still measure, discover and utilize. But rather: What does nature actually mean? From the perspective of nature. Seen through us, as long as we don't know the language. Roughly speaking, there are two perspectives.

On the one hand, we can access nature via the experiential knowledge of human protagonists - then QNR is a social science or ethnographic approach. The researcher looks at a nature professional and their nature expertise4 . The person is questioned, but it is about the nature with which this person is involved. Examples would be the farmer, the breeder, the hunter, the sommelier, the perfumer, the dressage rider.

On the other hand, we can investigate nature directly. What does the robin mean when it sings? How does the pig perceive its environment? What does it mean when lime trees grow differently? Can we learn to understand them better? Their signs, their tracks, their language, their interactions, also with us? A wide field opens.

QNR always has a scientific claim and contributes to an intersubjectively secured progress in knowledge.

Out of the niche - utilising the potential of QNR

Qualitative-empirical research is first and foremost a way of thinking and researching that needs to be learnt. QNR offers existing and future qualitative-empirical research styles a common methodological foundation without getting lost in discourses on scientific theory. QNR is simply another research option, in good co-operation with the quantifying NS. Let us be courageous and curious: QNR as a research loosener. With QNR, we can get closer to the "living" and better understand its meaning structures. Learning to think scientifically in a qualitative way is a fruitful opportunity for ecological and biodynamic agricultural science and can ultimately only be beneficial for any agriculture.

[2] *Examples for phenomenological goetheanistic research see Bockemühl (1997), Holdrege (2015), Vahle (2003), see image-creating methods for visualizing food quality (Fritz et al. 2022), see food induced emotions (Geier et al. 2016), or methodological analyses (Timmermann 2007).*

[3] *This was accompanied by an intensive discourse under buzzwords such as "crisis of representation" or "positivism dispute" (Adorno 1969), a discourse that is still pending in the Natural Science / Agricultural Science.*

[4] *Compare, for example, Timmermann, who has structured and elaborated the empirical knowledge in cereal breeding under the term "breeder's view" (Timmermann 2009).*

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6.Seeds and Plants

6.1 Co-Evolving with Nature: A 37-Year Maize Breeding Journey in Biodynamic Agriculture

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Contact: [email of corresponding author]

Abstract

Biodynamic breeding can enhance plant capacities for coevolution with microbiomes. This workshop explores a biodynamic maize breeding program that uses a partnership-style, "learning from the plants" approach. Landraces are crossed with commercial varieties, and selected for vigor, nutrient efficiency, and grain quality under nitrogen-limited, biodynamic conditions. Resulting varieties accumulate higher mineral levels and superior grain proteins. They are competitive in yield and with weeds and need less or no fertilizer. These varieties foster bacterial endophytes that multiply in vegetative and reproductive parts, supplying and cycling nutrients through rhizophagy and inducing systemic resistance to stress and disease. Findings parallel Rudolf Steiner's insights on plant genetic stability, elements, and 'living nitrogen'. Applying the Goethean method and biodynamic practices for breeding crops opens up a new path, holobiont breeding, for resolving planetary-wide problems with fertilizer, nutrition, and pollution.

Background and Aims

Maize is the sacred crop of indigenous people in the Americas. It is a remarkably productive and adaptable species which has enabled it to become the most produced cereal crop on the planet. Breeders view it as genetic machinery, farmers view it as a more-or-less profitable commodity or feed. And it is increasingly engineered for conventional farming by a handful of very powerful companies. The results have been greater efficiency of production under high planting density with agrichemicals, decreases in grain protein and mineral contents, smaller tassels, less pollen production, greater uniformity, poorer taste and nutritional value, contamination with transgenes, soil erosion, pollution and greater dependence of agriculture and national economies on maize.

There is a tension between the attitudes of indigenous peoples and the modern industrial mindset and this is reflected in their corn. Native corns are remarkably 'talented' in nutritional traits, their ability to adapt by shifting their genomes with the help of 'jumping gene' transposons, and their ability to interact with microbiomes to gain new services. Conventional varieties are very productive fixed products, that should be reliable wherever they are grown, given the right inputs.

We attempted to combine the best of both perspectives to meet the needs of biodynamic and organic farmers, animals, and consumers, and the Earth.

Methods

I have selected maize under biodynamic conditions for biodynamic and organic farmers, paying close attention to the plants. This work took place at two non-profit organizations, mainly in Wisconsin and on several organic and biodynamic farms and in cooperation with James White's team at Rutgers University, agricultural universities in Illinois, Iowa, Wisconsin, Puerto Rico and with several companies. In response to farmer needs, my breeding efforts shifted from 14 years of open pollinated population development to breeding inbreds, hybrids, and improved synthetic populations mainly from crosses between landraces and conventional inbreds. Plants were grown under biodynamic practices in Wisconsin, USA in the summer, but also under organic conditions, and in a few cases under conventional practices in Hawaii, Puerto Rico, or Chile in the winter to enable two crops per year. Selection in Wisconsin was on sites which were limited in available N, P, and K. Multiple applications of biodynamic preparations (up to 7x) were often utilized. Plants were sequentially inbred for mostly 6 generations. Selection considered vigor, nutrient uptake efficiency, nutritional value, grain yield, and performance in hybrid combinations.

Results and Discussion

The first major results were the mass emergence of soft textured seeds. These mutants contain higher levels of essential amino acids (methionine, lysine, and cysteine) and higher levels of minerals. This significantly shifted the value of the grain. Organic poultry farmers would not need to feed synthetic methionine to their layers and they could reduce the amount of soymeal by 9%.

Then it became apparent that our most efficient inbreds and hybrids are densely colonized with bacteria. These bacteria streamed in and through young tissues of roots, leaves, chloroplasts epidermis, silks, pollen, and embryos. They engendered dynamic movement in the protoplasm of tissues. The bacteria produced nitrate, ammonium, and nitric oxide while being chemically attacked by the plant's superoxide and hydrogen peroxide.

Bacteria are passed from generation to generation through seed. But the plants also take up large quantities of bacteria through their rooting systems, increase them in their hairs and tissues, and assimilate them in specific cells located in the roots, epidermis and glumes. Lipid studies confirmed that the plants were cycling large quantities of microbes and depositing their contents in plant leaves.

The plant/bacterial partnership is reminiscent of R. Steiner's description of 'living nitrogen' and the interactions between Carbon, Nitrogen, and Oxygen in the plant in the Agriculture Course.

These MI inbreds were much more vigorous and stress resistant than conventional inbreds and had very dark green leaves full of chlorophyll. They and their hybrids were also better at competing with weeds. The MI plants did not respond positively to fresh manure like conventional hybrids, but they responded positively to compost or to soils with a high content of microbial biomass. Isotope studies showed that some of the inbreds and hybrids were probably fixing substantial amounts of nitrogen with the help of their bacteria.

Large-scale, soft seed mutations only occurred when plants were grown under biodynamic conditions. Initial studies with biodynamic herbal seed baths suggest that they can strongly increase microbial colonization in maize leaves and enhance plant growth.

The intense bacterial colonization found in silks, pollen, embryos, and nuclei may be connected with a greater ability of the plants to generate variation in their offspring. It proved difficult if not impossible to breed clonal MI inbreds, even with excessive inbreeding. This makes them difficult to register with governmental authorities.

Conclusions

The application of "learning from the plants" approach, coupled with biodynamic practices, led to shifts in plant biology that are paradigm shifting and potentially of World significance. The results open up a whole new area of work: holobiome breeding, that could help humanity resolve the climate, pollution, and health problems associated with farming. They can reduce the need for fertilizer and enhance weed control, while resulting in higher value products. Under stressful conditions weeds often have these beneficial, adaptive, vitality-engendering partnerships even if our crop plants have lost them.

Biodynamic farmers should have 'dynamic holobiont' varieties. But dynamic holobionts can also be a present to the rest of the world. If this development is taken seriously, it could revolutionize biodynamic, organic, and conventional agriculture.

References

6.3 Induced epigenetic influences in plant (vegetable) breeding

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Abstract

Water-soaked seeds of various species have been treated with different vibrations and other environmental stimuli (eurhythmy, intervals, meditation) to find out about their effects on phenotype, taste[4] and nutritional quality.

In lettuce we found effects on the formation of the lettuce-heads.

In green beans we found effects on phenotype and the Brix-contents. These effects are stable through the generations.

In Dandelion we found, after two generations, different phenotypes and tastes of roots, leaves and or flowers.

The forming forces and nutritional quality of tomatoes and potatoes and different cereals could change to better wholesomeness and digestibility.

Moreover, sensitive copper crystallisation[5] was applied, as well as drop-pictures[6] and forming forces methods[7] showing reliable differences between the treatments.

Background

Studies have shown that noise and vibration can influence germination, gene expression, growth and disease resistance in plants[8].

As a breeder of vegetables my research question has been: How can I induce variation in plant species without crossing or genetic engineering (GM). Thus, by fully respecting the species' 'intrinsic value'.

During fifteen years of research, trials have been made on various crops (lettuce, broccoli, spinach, carrots, red beets and barley) to get find out about effects of various sounds and other signals.

4 https://thebiologist.rsb.org.uk/biologist/158-biologist/features/2129-safe-and-sound; https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3906434/
5 https://science.goetheanum.org/fileadmin/nws/text-downloads/flyerBWeng.pdf
6 http://www.waterresearch.org/about.html

7 D, Schmidt: „Lebenskräfte - Bildekräfte"

8 See note 1.

Effects on morphology and taste of the various treatments as well as their combinations have been compared, as well as those of yield mass and size. Based on the results of explorative trials, seed treatments for different crops have been selected and used to strengthen the resilience and nutritional quality of the crops' varieties.

Method

Seeds are soaked in little water to trigger their physiology, where after the various treatments are applied for a few minutes[9]. In some cases, different treatments have been combined (applied one after the other during the same treatment and/or a different treatment added for the next generation).

The seeds have then either been sown directly (SD) or first dried and sown later (SL) (this can be at any time also a year or more later).

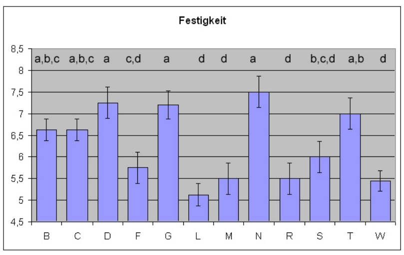
The treatments have been compared with untreated crops (controls). The same treatment has been tested on different crops and in different years or planting (SD and SL). Seeds of the treated plants have been harvested and been tested as such again up to seven generations after the particular treatment. There, no more treatments have been applied after the original one.

Results and Discussion

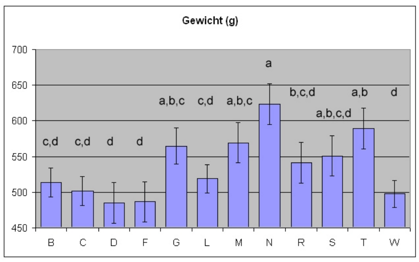
1. In <u>Lettuce</u> the goal was, to learn about the effect of the different planets and zodiac signs – and to find the most appropriate gesture to support the typical forming forces of the lettuce. Thus, we applied all zodiac signs, eurhythmic consonants, which belong to a certain zodiac sign, all single tones and intervals and compared them. We found differences in the forms and the different filling/ compactness of the heads and their weights. The differences were statistically relevant.

   Lettuce treated with eurythmie gestures. L and G

   Lettuce treated with different eurythmic consonants:

   compactness

   weight

2. In <u>Green beans</u> the goal was to improve the forming forces. We applied different eurythmic gestures and meditations throughout 5 generations. We found an improved food quality. This was documented by copper crystallisation and rational forming forces research[10].
   Although green beans are self-pollinators, over the years no selection has been done: they were just harvested and the seeds have been re-sown. We found after eight

9 As treatments sounds, gestures and 'focussed attention' were applied.
10 D. Schmidt in „Lebenskräfte – Bildekräfte 2011.

generations that, compared with the original variety, the morphological changes were so obvious, that the treated plants could be registered as a new variety.

Drip pictures of beans:

untreated

treated

3. In Dandelion the goal was to develop a crop with 'edible and nutritional' qualities. The focus was in particular on three different 'potential' organs: roots (R), leaves (L) and flowers (F). Seeds from a wild dandelion were separated in three badges (R, L and F) and treated in 3 different combinations of sound, movement and meditation. Subsequently they were cultivated, selected, their seeds harvested and treated again. Differences could be recognised already after two generations. This process went on during the next – now seven – generations.

   In the R treatment we found that the main root was stronger, straighter and thicker. The root- taste is slightly little bitter but good to eat. However, the leaves are not digestible.

   In the L treatment we found that the leaves are broader and less bitter and very good to digest even if eaten in a high quantity. However, they flowered 1-2 weeks later than F, with much less flowers.

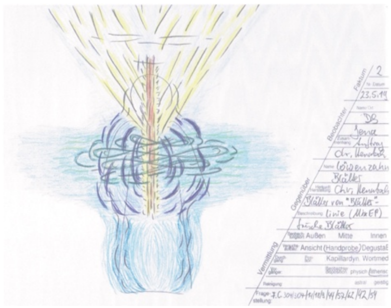
   In the F treatment we found much more flowers then both other variations and earlier flowering. The flowers are somewhat sweet and good to digest. However, the leaves are bitter and not to digest.

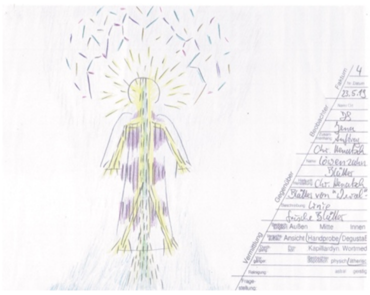
It was found that even after years the treatment had still the same effect as was found after direct sowing.

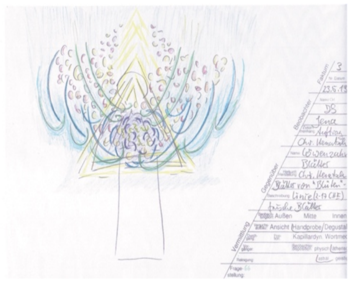
The 3 variations showed quite different forms in the picture methods applied, and each very different form the original Dandelion.

In the following forming forces pictures (observation and pictures by D.Schmidt, forming froces society show the differentiation from the wild form

into





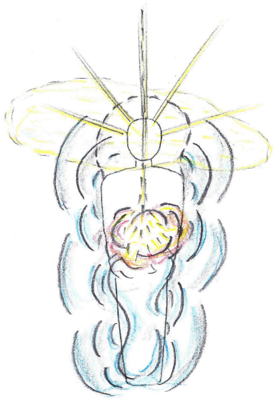


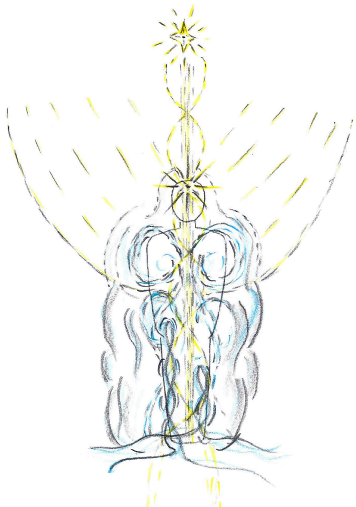
root leaf flower type:

Dandelion treated for Leaves reated for flower, pictures taken at the same day

4. In <u>tomatoes</u> and potatoes the aim was to change the nutritional quality (as nightshade plants are considered difficult to digest for human consumption, especially for people whp suffer from cancer and similar deseases.

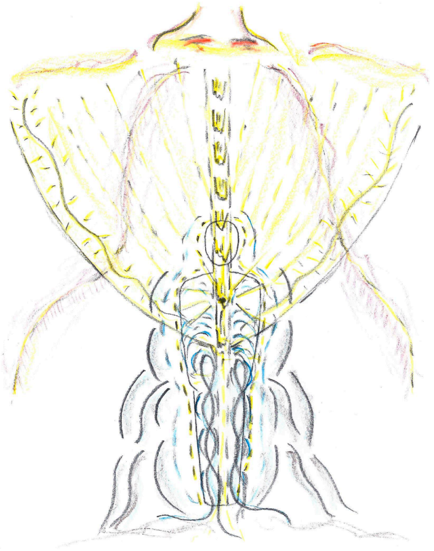
Two potato varieties were treated: (observation and pictures by M. Buchmann, forming froces society)





Potato untreated
Working of light in the head due to spraying of silica; equisetum – weving, not formed, swelling growth forces.

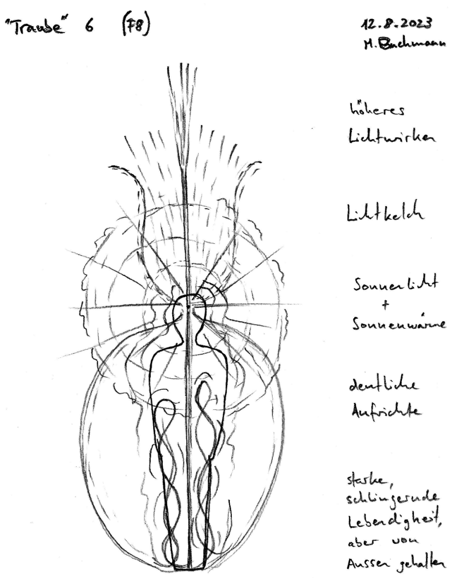
Potato treated
A connection to the being of the potato is present
> an uprightness comes into the gesture, the heaviness of the potato is pressed down, the swelling forces enliven the breast.



Potato untreated
Working of light in the head due to spraying of silica; equisetum – weving not formed, swelling growth forces.

Potato treated
A connection to the being of the potato is present
> an uprightness comes into the gesture, the heaviness of the potato is pressed down, the swelling forces enliven the breast.

A hybrid tomato was treated throghout 8 generations: (observation and pictures by M. Buchmann, forming froces society)



Tomato: Perlati F1

All life-forces follow a strong suction into heaviness as as if you have a coat of lead. Especially in the head

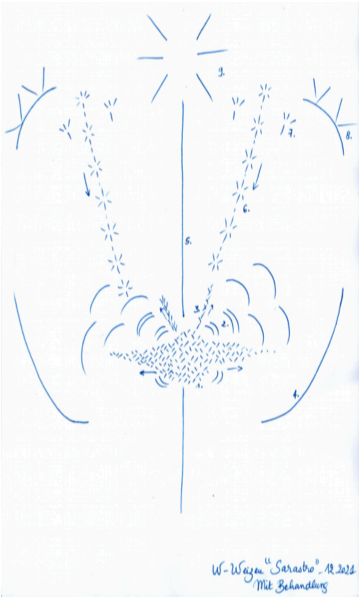
Traube 6 (now registered as „Tiamarie“)

A strengthening of uprightness which has not been observed at tomatoes before.Swelling ether forces and warmth forces work the forces remain blunt and dull. All life forces, which would stream up, remain in stiffness.

in the digestion, and animate the liver. In the upper part sunny light and the forces of consciesness can light up clearly. In the middle part, the two forces come together in harmony and lead to an harmonious ether gesture.

5. Different cereal corps (wheat, rye, millet, oats etc.) were treated through several generations (1-5) with eurythmic and meditation to improve the nutritional quality and digestibility for people with gluten- intolerances. Forming forces pictures show a change of the gestures. People with intolerances report a better digestibility.

A wheat (Observation and picture by Audrey Krebs, forming forces society): left untreated – right treated



Little uprightness and warmth the cosmos.
Dark downwards flowing streams.
Overstructuring „Z" forces, pressure.

Stronger uprightness, opening to the forces of pulsing, covering warmth life ether forces unfold themselves, active structured.

Stream of compact blocking substance (gluten).
The being seems barren, little communicatiom
Impression of heaviness

Uprightness, presence, streaming warmth, the gluten is streaming, circulating the gesture is in a wide golden vibrating room.

Conclusions

1. It could be shown that it is possible to influence the way plants grow and develop, as well as their nutritional quality through seed treatments with sounds, gestures and focussed attention.
2. The effect can be repeated and is predictable.
3. The effect of single treatments were found to be intact over generations.
4. The applied treatments might be referred to as ways for ‘dialogue’ with the plant species.

References

6.4 Climate change adaptation strategies for biodynamic garlic cultivation

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Abstract

Agroforestry and organic mulching promise to increase climate resilience of crop cultivation and simultaneously regulate greenhouse gas emissions. These practices may be particularly suitable for perennial crops highly dependent on a predictable environment and with relatively poor competitive ability. Twenty garlic varieties were grown with and without hay mulch in an agroforestry or open-field cropping system under biodynamic conditions for two years. Soil temperature variation was moderated and the average bulb weight per plant was 30% higher under mulch and 8% higher in the agroforestry system. Biodynamic growing practices and variety diversity offer promising future perspectives.

Background and Aims

Climate change severely impacts biodynamic as well as conventional agriculture. Agroforestry and organic mulching promise to increase climate resilience by improving the microclimate (temperature and moisture) and soil structure (Carr & Congreves 2020, Luís et al. 2020, Haque et al. 2002). Simultaneously, greenhouse gas emissions may be regulated by sequestering (soil organic) carbon (Mayer et al. 2022; Tiefenbacher et al. 2021). These practices are studied in the case of biodynamic garlic cultivation considering variety diversity.

Methods

Twenty garlic varieties were cultivated with and without hay mulch at two locations, in an agroforestry and in an open-field cropping system, both on a biodynamic farm in Germany. Four replications of 10 plants each were used per variety x treatment x location combination. Soil temperature was recorded every hour. The mean bulb weight per plant was measured and statistically analysed.

Results and Discussion

The mean bulb weight per plant was 11% and 50% higher under hay mulch in the first and second year, respectively (averaged over varieties and locations). Moreover, the mean bulb weight was 13% and 1% higher in the agroforestry system in those two years (Table 1).

Table 1 Average bulb weight with and without hay mulch in the 2021/2022 and 2022/2023 growing seasons at two different locations at Dottenfelderhof

Treatment	**Average bulb weight 2021/22 [g]**	**Significant difference ***	**Average bulb weight 2022/23 [g]**	**Significant difference ***
With mulch	49.6	A	57.2	A
Without mulch	44.4	B	38.2	B
Location				
Agroforest system	50.0	A	48.3	A
Open-field cropping system	44.0	B	47.1	A
* Different letters show significant differences p> 0.05 between the two pairwise comparisons with / without mulching and agroforestry / open-field cropping system using t-tests				

These yield advantages are remarkably high given that they can be attributed exclusively to the use of ecologically favourable cultivation practices. Possible explanations for these results include a more even temperature change during the vegetation period extending the assimilation phase. They are in line with the corresponding measurements and findings of Dix (2024) or Portela (2013). Additional effects may include soil improvements, a higher moisture retention, and increase microbial activity. The weight differences between the highest and lowest yielding variety amount to up to 130%, with some variety x practice interactions.

Conclusions

The adoption of agroforestry, hay mulch as well as suitable varieties offer the potential to increase the climate resilience of biodynamic garlic cultivation.

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7.2 Long-Term Effects of Biodynamic Practices on Soil Fertility and Wheat Quality: Insights from the Frick Trial

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Abstract

In the Frick trial, a long-term experiment (LTE) initiated in 2002 at FiBL, Switzerland, the effects of tillage, fertilization, and biodynamic preparations on soil fertility and crop quality are investigated. A new project (2024-2027) in this LTE focuses on soil microbial functional diversity using high-throughput sequencing and metagenomics. The LTE employs a full factorial design, separating the effects of biodynamic preparations from fertilization and tillage. Previous research has shown improved soil quality in biodynamic systems, with effects on soil microbial communities and nutrient cycling. In addition to the biodynamic compost, the preparations can also have an effect on the microorganisms. Soil samples from 2024 are analyzed for organic carbon, pH, minerals, and microbial biomass and wheat samples for yield and nutrient contents, and quality with image forming methods. DNA sequencing of microbes from soil allows identification of metabolic pathways related to carbon, nitrogen, sulfur, and phosphorus cycles. The study aims to deepen our understanding of how biodynamic management influences long-term soil fertility and wheat quality.

Background and Aims

In FiBL's oldest long-term field experiment (LTE), the DOK experiment, various differences were observed between the biodynamic, bioorganic and conventional systems (e.g. Mäder et al. 2002; Krause et al. 2024). However, these differences cannot be attributed to individual factors such as manure quality or the biodynamic preparations due to the DOK's experimental set-up as a system trial. The comparison of systems is intentionally based on the package of various management practices with regard to fertilizer type and amount, and plant protection. Factorial trials are needed to investigate a preparation effect separately from a fertilizer effect. For this reason, a new LTE was set up at FiBL in 2002, which considers the influence of preparations separately from fertilization. In addition, tillage was integrated as factor with the comparison plow *vs.* reduced tillage. Both measures, compost addition and reduced tillage, are expected to lead to improvements in soil fertility over time through the promotion of an active and functional diverse soil life as a healthy basis for plant production. Reduced tillage has a beneficial effect on the soil's micro-, meso- and macrofauna due to reduced soil disturbance (Krauss et al. 2020; Schmidt et al. 2020; Betancur-Corredor et al. 2022). The fertilization with composted manure has an important function for soil life, as it nourishes it with organic carbon and nitrogen compounds. Biodynamic preparations may act via non-material forces, but there have recently been indications that they could also exert a material influence on soil microorganisms (Juknevičienė et al. 2019; Fritz et al., 2020, Milke et al. 2024). In a new project started in 2024, the influence of the three experimental factors on the soil metagenome, on soil chemical and biological parameters, as well as on yield and weed development, and crop quality will be investigated. Furthermore, the aim is to investigate whether there are interactions between biodynamic cultivation and the type of tillage or fertilization.

Methods

On 1 March 2024, soil samples were taken on all 32 plots (ploughing or reduced tillage, manure compost or slurry fertilization, with or without preparations, four replicates) of the Frick LTE at depths of 0-10 cm and 10-20 cm, with at least 8 subsamples per plot. These were cooled at <4°C immediately after sampling and then prepared in the soil laboratory for the subsequent analyses, i.e. one subsample was separated with sterile gloves and sieved to 2 mm for DNA extraction, one part was sieved to 2 mm for the analyses of pH, total nitrogen (TN) and soil organic carbon (SOC), and one part was kept cool for the extraction of microbial biomass C and N (C_{mic}, N_{mic}). Wheat samples were taken by hand on 15 June 2024. The influence of management on the quality of the wheat grains of 2024 was investigated using image forming methods of copper chloride crystallization according to Pfeiffer and the WALA rising images (Busscher et al. 2014; Steffen 1983). The statistical analysis of the agronomic data was carried out with IBM SPSS Version 23, in form of an ANOVA with tillage, fertilization, preparation, and depth as fixed factors and block as random factor.

Thanks to the latest developments in high-throughput sequencing technology, the metabolic potential of a soil can be characterized by comparing the entire genetic information of a soil with global databases and subsequent assignment to individual metabolic processes (Huson et al. 2016; Bağcı et al. 2021). The complex bioinformatic analysis requires access to powerful computing capacities, but allows a high-resolution analysis of possible metabolic pathways. In this way, the functional diversity can be characterized independently of the taxonomic structure of a soil microbial community, and the long-term effect of agricultural measures on a variety of soil functions can be compared. For this purpose, the soil samples of spring 2024 were homogenized and DNA extracted from a subsample. In addition, DNA was extracted from slurry and manure as well as the preparations (BD500 - horn manure, BD502 - *Achillea millefolium* L., BD503 - *Matricaria recutita* L., BD504 *Urtica dioica* L., BD505 - *Quercus robur* L., BD506 - *Taraxacum officinale*, Wiggers, BD507 - *Valeriana officinalis* L.). DNA was extracted at the FiBL laboratory and the sequencing was carried out by the Functional Genomics Center Zurich (FGCZ) on the Illumina NovaSeq X platform. An average of 114 Mio paired-end reads per sample was achieved. The analysis includes a comparison with the two general ontologies eggNOG and SEED (Huerta-Cepas et al. 2018, Overbeek et al. 2005), and the two special databases CAZy and NCycDB (Drula et al. 2021; Tu et al. 2018), which classify genetic information according to different criteria. CAZy and NCycDB have a special focus on genes related to the carbon and nitrogen cycle, respectively. Genes related to the sulfur and phosphorus cycle, SCyc and PCyc, will also be investigated (Yu et al. 2021; Zeng et al. 2022). Through the subsequent statistical analysis, the functional genes of various metabolic processes that have changed due to the influence of cultivation can be identified.

Results and Discussion

Regarding SOC and C_{mic} as indicators for soil fertility, tillage had a significant effect (p=0.000) on SOC in both the 0-10 cm and 10-20 cm layers. The content was higher with reduced tillage than with plowing. The factors fertilization and biodynamic preparations had no significant effects on SOC and C_{mic} in 2024, but there was a significant interaction of tillage*biodynamic preparations (p=0.049). With plowing, i.e. in the treatment with lower SOC content, there was a tendency for a higher SOC content with biodynamic preparations than without, while with reduced tillage, i.e. the treatment with higher SOC content, there was a tendency for a lower SOC content with biodynamic preparations than without. The same was the case for TN (p=0.007). This could possibly show a balancing effect of the biodynamic preparations. Regarding C_{mic}, tillage had a significant effect (p=0.001) with higher values for reduced tillage compared to plowing in both soil layers. A similar trend for the effect of biodynamic preparations like for SOC could be observed for C_{mic}, however, it was not significant.

The investigation of wheat quality using image-forming methods showed only slight differences between the treatments. The classification could not be made correctly.

While the statistical analyses of the metagenome data is currently ongoing, the data processing already revealed a high yield, indicating sufficient sequencing depth and coverage as a solid foundation for the functional profiling. First results of the functional diversity analysis of the soil microbiome will be part of the presentation.

Conclusions

In the Frick LTE, the tillage factor has the strongest effects on most parameters assessed. Interactions with the factor biodynamic preparations occur, which require further attention. Results for the metabolic potential of the soil will follow.

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7.3 Crop Production and Environmental Impact of Organic and Conventional Farming Systems

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Abstract

Agriculture provides food to a still growing population but is a major driver of the acceleration of global nutrient flows, climate change, and biodiversity loss. To assess long-term environmental impact of organic food production we synthesized research on agronomic and environmental performance of the 47 years old DOK experiment, which compares organic (bioorganic and biodynamic) and conventional (integrated and mineral-based) cropping systems. Despite strong reduction of inputs, yields of the organic systems achieved 85% of the conventional systems. Organic cropping systems, especially compost-based biodynamic, showed enhanced soil health, richness of micro- and macrofauna and weed species. We demonstrate at field level that organic cropping systems with reduced external nutrient inputs have less climate impact and a larger in-situ biodiversity, while providing a fertile ground for the future development of sustainable agricultural production systems.

Background and Aims

Agricultural systems put severe pressure on the environment, and management practices balancing the need for agricultural production and environmental health are urgently needed. Key environmental challenges for agricultural systems include the reduction of nutrient losses, the mitigation of greenhouse gas emissions and the preservation of soil biodiversity. Organic cropping systems are proposed as environmentally friendly alternative to conventional systems due to their focus on long-term soil quality but often show lower yields.

Methods

In this study we present the results from a 42-year-old field trial (DOK trial), located in Therwil, Switzerland on key agronomic and environmental parameters. The trial compares two organic (BIODYN, BIOORG) and two conventional (CONFYM, CONMIN) farming systems with an unfertilized control (NOFERT) and follows a system comparison approach. Farming systems mainly differ in plant protection and fertilization strategy but follow the same tillage system and 7-year crop rotation. CONFYM receives the highest external inputs in terms of nutrients and chemical plant protection followed by CONMIN, BIOORG, and BIODYN. The biodynamic treatment includes composting of manure and the use of biodynamic preparations for plant health treatments and composting.

Results and Discussion

Across the five main crops (grass-clover, wheat, potato, maize, and soybean), organic cropping systems maintained yields at ~85% of conventional systems with distinct differences between legume and non-legume crops (Knapp et al., 2023). Highest yields were achieved in the integrated conventional system, with highest total nitrogen inputs and enhanced soil health compared to pure mineral fertilization. Yet, these benefits come at the cost of lower nitrogen use efficiency and higher N_2O emissions (Krause et al., 2024; Oberson et al., 2024). Organic systems used 92% less pesticides and 76% less mineral nitrogen than conventional systems. Cropping systems receiving organic inputs at a rate of 1.4 livestock units per hectare and year stabilized (BIOORG, CONFYM) or even enhanced (BIODYN) soil organic carbon and nitrogen stocks. Yet, soil organic carbon and nitrogen contents evolved slowly and differences became statistically significant only after 22 years (Krause et al., 2022). All fertilized cropping systems showed a positive nitrogen balance when nitrogen fixation via legumes was included. Still purely mineral fertilized (CONMIN) and unfertilized (NOFERT) systems lost soil organic carbon and nitrogen on the long term (Oberson et al., 2024). Organic cropping systems significantly reduced soil borne climate impacts, which was rather driven by nitrous oxide emissions than by changes in soil organic carbon contents (Krause et al., 2024). Higher richness of soil fauna and weed population was observed in organic cropping systems, next to enhanced biological soil quality indicators, especially in the compost based biodynamic system (Krause et al., 2022). The functional potential of the soil microbiome showed a gradual change from organic (BIODYN, BIOORG) to conventional (CONFYM, CONMIN) systems highlighting the impact of cropping systems on soil functions (Krause et al., 2025).

Conclusions

With the present study, we could show that with moderate yields gaps organic cropping systems can reduce pressure on the environment by enhancing soil biodiversity and reducing soil born climate impacts. Soil health especially benefited from composted manure, as applied in the biodynamic system.

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7.4 Soil Health: Unlocking Potential for Climate-positive Gardening

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Abstract

With climate, nutrition, and biodiversity crises intensifying, gardeners and farmers are united in the desire to manage soils better. Plant growth, carbon storage, and ecological benefits are shared and desirable aims. With each goal scoring another (e.g. plant growth driving ecological functions and carbon storage) it is reassuring to know that nature is 'on our side' when it comes to climate-positive gardening**.**

How this works:

Plants bring products of the sun and air (CO2 → biomolecules) down into the soil, and out through the roots (called 'root exudates' or 'rhizodeposit-C'). However, plant root exudates may only be present in soil for just a few hours as soil microbes rapidly assimilate these nutritious compounds. Microbes convert plant sugars into proteins, and more complex biomaterials, including 2 key components of a healthy soil 1) Microbial Biomass, and 2) Extracellular Polymeric Substances (EPS). This soil biology, and its extracellular framework (EPS), stabilise a complex and functional soil architecture, imparting vital biochemical functions – including carbon storage. Thus, the power of plants and soil biology combine, supporting each-other by generating a healthy soil which stores carbon: *mitigating climate change*. Whether we think of ourselves as gardeners or farmers, or proactive in slowing climate change – we all want soils which grow plants better, for longer – without cost to biodiversity.

RHS Wisley's Soil Health Platform is a new long-term experimental site for collaborations investigating the generation of soil health (via plants and the soil microbial biomass). We believe that through informed gardening practices, all of us can contribute to soil health improvements and climate mitigation with greater confidence. This is the essence of "climate-positive gardening". The old ways of habitually digging in large quantities of organic carbon produced elsewhere (e.g. peat) which then mineralises to CO_2 is now recognised as unsustainable. Instead, putting *plants, carbon sources, and gardening practices* to best effect will empower gardeners and farmers alike to grow more sustainably.

RHS Hilltop: Our recently equipped laboratories are poised to measure microbial biomass and activity (ATP); formative microbial exudates (EPS); soil structural generation (WSA); and mineral-associated organic carbon (MAOC). We also aim to account for the different sequestration values for different C-Pools (Fossil fuel-C, Biomass-C, soil MAOC) enabling the trade-offs between fossil fuel-C, and shorter lived pools of C to be understood and communicated by our scientists and national advisory team. In this way we can identify what practices, on what soils, reap the greatest benefits for growers, the environment, and future biodiversity.

8.3 The Biodynamic Movement and Demeter in the Time of National Socialism. Actors, Connections, Attitudes

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A Summary

Biodynamic agriculture counts among the earliest forms of organic agriculture in Germany. In response to its centenary, Demeter e.V. and the Forschungsring (the German association for biodynamic research) worked together with the General Anthroposophical Society, the Section for Agriculture at the Goetheanum and Demeter International to establish an independent research group to investigate the role of the biodynamic movement in Nazi Germany. The study was supervised by a five-member scientific advisory board. The clients associate the project, on the one hand, with the goal of critically examining the history of their predecessor organizations. On the other hand, the aim is to set a clear signal with which the participating associations distance themselves from totalitarian orientations and groups or attitudes that discriminate against people in the present.

The core of the study concerns the relationship between the biodynamic organisations and the institutions of the National Socialist (NS) state as well as the motivation of those active during the dictatorship. Numerous publications rightly point out that in no other field of anthroposophical work was there such a readiness to cooperate with the national socialist government than in the biodynamic movement. Conversely, no other anthroposophical project engendered such interest among certain circles of the Nazi leadership.1 Some members of the Nazi elite believed they could use biodynamic agriculture for their own ends despite being highly critical of anthroposophical ideas. The biodynamic movement was the only field of anthroposophical practice that was integrated within the complex and overlapping structures of the National Socialist Party (NSDAP) and the state.

By drawing on source material that was previously unknown, the authors describe in just under 500 pages, the chronological development of relations between biodynamic practitioners and the national socialists. Apart from the key period under investigations, the years of national socialist rule, they also consider what led up to the establishment of anthroposophy-inspired agriculture from about 1920 onwards in order to provide a context for the subsequent decisions and procedures. A brief look at the post-war period up to 1950 explores the extent to which 1945 became a turning point for the biodynamic movement. The study is dedicated primarily to the multi-faceted conception of biodynamic agriculture and Demeter during the Third Reich. It highlights ideological overlaps and the various forms of cooperation, including collaboration, as well as the far-reaching ideological differences

between the National Socialist and biodynamic movements, and the attempts at resistance by supporters and functionaries.

The question of how to interpret “Nazi involvement” was itself the subject of the investigation, since the procedures for political and legal judgment or criminal prosecution have changed several times since the Allied denazification proceedings and the German “Spruchkammerverfahren” after 1945. Drawing on comparable projects that have examined the role of associations or institutions during the Nazi era, the study differentiates between three different “categories of guilt”:

1. “Formal guilt,” i.e., the question of membership in the NSDAP and in organizations classified as criminal, such as the SS,

2. “concrete actions”, a potential debt resulting from certain actions that, have been classified as criminal,

3. an ideological or programmatic overlap with the Nazi system: The authors understand this to mean agreement with the central programmatic Nazi ideologemes: racism, anti-Semitism, imperialism, chauvinism, and the extermination of “unworthy” life.

The Results

As part of the study, the NSDAP membership of more than 500 members of the biodynamic associations was reviewed for the first time. According to the study, the figure was just under 10% of the entire membership. By way of comparison, around 20% of all Germans eligible to vote were party members in May 1945. The authors admit that the figure must remain provisional, however, since there is no central biodynamic membership file and it had to be reconstructed from various sources. In addition, for many of the 1067 members of the biodynamic movement identified, the personal data required for a clear assignment to NSDAP membership was missing.

The question of ‘concrete actions’ and ideological crossovers was investigated chronologically by drawing on numerous sources that included more than thirty public, private and organisational archives in Germany, Switzerland and Ukraine as well as professional journals. Many records were unexpectedly discovered about the National Biodynamic Society (Reichsverband für Biologisch-Dynamische Wirtschaftsweise in Landwirtschaft und Gartenbau e. V.) in the national archive. This is quite remarkable considering how small and economically insignificant this society was with its less than 2000 members. There are various reasons for this. In the first place being engaged with anthroposophy meant that biodynamic practitioners were under surveillance by the Gestapo and security forces and monitored as enemies. These records comprise more than 10,000 pages. The correspondence records of ministers and SS officials amongst themselves or in communication with the National Biodynamic Society, is almost as extensive. It can be safely assumed that the presence of the NBS was not welcomed by the national socialist (NS) state but was rather a cause of alarm right through to the party leadership. At no point the “NS chief ideologists” had been in doubt that anthroposophy and its fields of practice were “incompatible” with National Socialism.

Thanks to the comprehensive nature of the sources available, this study has been able to fill many gaps in the history of the biodynamic movement. In some cases, the results diverge from previous work on this theme.[2] Some of those theses could not be confirmed and this led to a new and more differentiated assessment of certain specific relationships.

The assumption – made for instance by the American historian Peter Staudenmaier – that biodynamic agriculture and national socialism had 'the same roots'[3] and that it was therefore a 'matter of course that they would work together after 1933', has since become widespread. It was stated on German radio for example in the context of the centenary of biodynamic agriculture that the 'soil focus of anthroposophic thought' and the 'esoteric leanings of leading national socialists' had so to speak 'sought out and found one another' in the national socialist state. And furthermore that this close ideological connection led on to collaboration and a blossoming of biodynamics in the dictatorship.[4]

At first glance this assumption appears plausible, when we think of concepts such as 'blood and soil' or the esoteric tendencies among certain leading figures in the party. And it is a fact, that both the biodynamic movement and national socialism, started around the same time in the context of the so-called reform movements. What the various reform movements had in common was a shared analysis of what was wrong with for example capitalism or more generally the rationalisation of life.

Despite these similarities, the two movements differ fundamentally on the question that is the focus of the study. Nowhere in all the documents, statutes, letters or publications, including the period prior to 1933 and the "Agriculture Course" (Steiner's first lecture in 1924 on the later biodynamic agriculture) itself, have the authors found anything that would accord with the ideological policy programme of the national socialists. Racism and antisemitism played no role in the writings of the biodynamic movement. This finding is worth noting since even before the Nazi dictatorship the concept of 'race theory' was not only considered socially acceptable but was widespread. There were sport- and gardening clubs even before 1933 for instance, whose constitution explicitly excluded Jews.

This finding then led to a new set of questions: If biodynamic people were not followers of Nazi ideology when they started – so the argument goes – why were they so ready to immediately engage with the Nazi regime after 1933 – and thereby bring stability to a criminal system?

During the Nazi era, the development of the biodynamic movement can be outlined as a contradictory process between repression and collaboration, of a rise and fall of biodynamics.

1. The Struggle for Recognition and the forced "truce" imposed by Rudolf Hess

Up until the end of 1933 the National Biodynamic Society found itself in a critical situation despite efforts to make a connection during the early stages of national socialism. From the very beginning, the biodynamic movement had been rejected by the entire national socialist agricultural apparatus and was a thorn in the side of the new regime and especially of IG Farben, one of its most important business partners. The conflict between these two unequal organisations had already begun at the end of the 1920s when the young and rebellious biodynamic movement strongly attacked IG Farben in its first publication. They questioned the hegemony of the agrichemical industry and the industrialisation of agriculture and called upon farmers to help themselves.5 Because of the simultaneous criticism of artificial fertilizers in the media, the agrichemical lobbyists felt vulnerable and responded with a massive campaign against biodynamic agriculture. Were it not for supporters within the dictatorship the National Biodynamic Society would of necessity have soon gone under as a result of the agricultural changes caused by the 'battle of production'. It is clear from the reports that the agricultural ministry, food council and especially the food industry were not prepared to tolerate this tiny 'agent provocateur' despite its productivity being generally perceived as poor.

That the National Biodynamic Society was able to gain traction in the national socialist system at the beginning of 1934 despite this manifest rejection, was solely due to Hitler's deputy, Rudolf Hess. He was the only man in the regime with the authority to counter the powerful agrichemical lobby. And he did so by enforcing a kind of truce. Although agriculture was certainly not one of his competences, Hess demanded that a comprehensive assessment of the biodynamic methods be carried out and overseen by the nutrition council. According to Hess, the Society should continue operating as a potential 'future form of healthy agriculture' and be protected from defamation and attack by the press or other authorities, until the results were available. The records also show that even after provisional protection was granted by Hess, the continued existence of the society was only possible because several of his colleagues – Dr. Griesbeck, Dr. Hörmann, Hanns Georg Müller, Prof. Franz Wirz and to some extent also the leader of the national doctor's council Gerhard Wagner – continually sought exemptions for the National Biodynamic Society.

Why Hess invested so much time and bureaucratic effort in support of biodynamic agriculture is frequently linked in the literature to his interest in esotericism or sympathy for anthroposophy. The research however was unable to confirm this assumption. He was interested in it more from a health perspective and as a means to reform life styles especially in the field of medicine. It is highly likely that along with other early national socialists, he had become familiar with the biodynamic approach in the context of health spa reform in the late 1920s where it was seen as a 'healthy' form of agriculture. Several doctors had at that time made the connection between the appearance of new forms of illness and a disturbed mineral metabolism caused by the use of chemical fertilizers. Since Demeter was the first certifier of artificial fertilizer-free products, its produce was used not only in anthroposophical children's homes but also as a health diet in some health spas.

This is most probably the reason why Hess – and subsequently other leading Nazis who were interested in alternatives to artificial fertilizers – sought out biodynamic and not other forms of ecological agriculture. Apart from biodynamic agriculture there were in fact at least two alternative approaches from Ewald Könemann and Wilhelm Büsselberg, that were ideologically far closer to national socialism.6 It seems from this perspective that ideological considerations were not decisive for Rudolf Hess, Heinrich Himmler or Walther Darré. Their interest was connected far more with the practical experience which biodynamic farmers had of fertilizing the soil without chemicals – also on large farming estates and in new settlements –and especially their well developed concept of agricultural training. In both these areas biodynamic farmers were way ahead of others. Hess helped National Biodynamic Society to survive because he was convinced that chemical-free fertilization was vital for the 'health of the people' and included it within his plans for a national socialist health service.

It is not possible to speak of a general acceptance or of a collaboration of the National Biodynamic Society with the Nazi regime during the first period leading up until the start of 1934. Records of the correspondence between the office of Hess and the Biodynamic Society show how from the middle of 1934 both of its representatives – Erhard Bartsch and Franz Dreidax – were increasingly integrated within the regime's structure, how they were 'built up' by members of Hess' staff and the kind of influence they had on the biodynamic team. From 1934 till 1941 the collaboration with and repression of the Biodynamic Society became increasingly intertwined.

2. The rise of the Biodynamic Society

From 1939 a struggle began to determine who would be responsible for planning what the regime euphemistically called the "colonising of new lands". In the polycratic national socialist state, government departments, SS institutions and the imperial ministry of agriculture were quarrelling over the so-called settlement question. In early 1939 at the latest and with the prospect of war looming, an unexpected turn of events occurred which for the leaders of the biodynamic movement must have felt like a dream come true. Some of NS politicians were no doubt hoping for the support of the Biodynamic Society with their huge settlement project for the occupied territories.

Records of the correspondence between the various party and state authorities show, that for differing reasons, a wider group of functionaries were supportive of biodynamic agriculture and the National Biodynamic Society. These included the home office minister Wilhelm Frick and member of parliament Walter Granzow. One of the earliest and most important mediators between the NS state and the Biodynamic Society who should be mentioned, is the 'national landscape consultant' Alwin Seifert.[7] Seifert was predestined for this task firstly because since the 1920s he had been in contact with those who would later become leading figures in the national socialist regime and secondly because he was not an anthroposophist. He had discovered biodynamic agriculture back then as a landscape architect and was impressed by the approach both practically and as an ecologist. In his capacity as landscape consultant working on the integration of motorways into the landscape, Seifert gathered many landscape advisors around him including some who were members of the Biodynamic Society.

It was Lotar Eickhoff who as ministerial advisor in the home office, made a powerful case for the Biodynamic Society. Increasing interest was also shown by Robert Ley the leader of the German workers forum. Albert Friehe an early member of the NSDAP, writer on racial policy, an activist and from 1935 mayor of Bückeburg, was a director of the Biodynamic Association in Bückeburg and also a member of the Biodynamic Society.

From mid 1939 onwards a number of senior members of Hermann Reischle's team on the imperial food council began to take an interest in biodynamic agriculture in quite a new way. Reischle, as director of the Food Council had strongly supported the advance of Darré's NS agricultural policy career since 1931[8] and had taken part in a farm visit to the model biodynamic farm of Marienhöhe. In the spring of 1940 he initiated a press campaign to make this 'natural farming approach' more widely known[9] and in March 1940 agreed to a publicity drive on the subject with Josef Goebbels, the minister for information and propaganda. In connection with this, a number of scientists within the Food Council were engaged in assessing and writing papers to re-evaluate and strengthen biodynamic agriculture.[10] Unlike previous assessments of biodynamic agriculture undertaken by the Imperial Food Council this 50 page document by Wilhelm Driehaus came to a very positive conclusion. He wrote about a potentially spectacular 'transformation' of agricultural policy.[11]

Finally in April 1940 Günther Pancke – the head of police and General of the Waffen-SS , director of the SS Race and Settlement Main Office (Rasse- und Siedlungshauptamt der SS) from1938 and from 1939 the coordinating officer between the Führerhauptquartier (Hitlers Headquarter), the SS-Totenkopfverbände and the Sicherheitsdienst SD (Security Service, SD) reported that there was now a broad alliance in support of biodynamic agriculture that included the ministry of agriculture, Rudolf Hess and the SS-Wirtschafts-Verwaltungs-Hauptamt (SS Main Economic and Administrative Office) under Oswald Pohl.[12]

From this moment on, members of the Biodynamic Society were euphoric about the results and hoped for a massive breakthrough. When the war started, its chairman, Erhard Bartsch, regularly sent the various NS authorities new papers extolling the value of biodynamic agriculture for the war economy and especially for the settlements in Poland. This led to numerous visits to the model farm of Marienhöhe during this period by NS functionaries. Joint associations were founded and some NS institutions even gave financial support to the Biodynamic Society so that it could found its own training centre, the so-called Demeter Haus, in Bad Saarow.

The high point came in the summer of 1940 with the visit to Marienhöhe of the minister for agriculture Walther Darré, and especially with his concluding statement, that called for greater recognition of biodynamic agriculture in the future. This statement however must have set the alarm bells ringing in the agrichemical industry for it resulted in a major offensive by IG Farben. It took the form of a comprehensive paper attacking biodynamic agriculture – a position paper on the question of Biodynamic Agriculture' written by Dr. Alfred Steven. It was then sent to all the relevant departments of the party and state. Its argumentation is what laid the groundwork for the prohibition of the Biodynamic Society that followed soon afterwards.

3. The banning of the Biodynamic Society

The Janus-faced nature of the national socialist movement has been frequently referred to. While one section of the party challenged the profiteering of the agrichemical industry and gave space to a traditional farming lifestyle, another recognised that the new 'Lebensraum' concept could only be achieved by employing a high degree of rationalisation in partnership with industrial power. When the National Biodynamic Society was banned on the eve of the invasion of the Soviet Union it was this section of the party that took over and which would then use the most modern means available to drive forward the war of annihilation – including a highly industrialised agrichemical approach to agriculture.

When its most powerful protector Rudolf Hess fled to England in 1941, the opponents of biodynamic agriculture within the NS leadership took control. On 9th June 1941 as part of the nationwide 'campaign against occult teachings and so-called occult sciences', the Biodynamic Society was dissolved and its staff forbidden to engage in any kind of anthroposophical activity. With this prohibition the whole system of production, distribution and consumption in the German biodynamic network was destroyed. The products could no longer reach their customers. The farms had very little security. Advertising of and information about biodynamic products was banned and agricultural estates and farms producing biodynamic food could only continue doing so as long as it was not promoted publicly.

However, the ban was not enforced with the same radicalism and violence as the bans against communists, social democrats or trade unionists at the time. This explains, for example, why, even two weeks after the ban, the visit of a group to the model estate Marienhöhe was tolerated by the Gestapo, although it was monitored. It is astonishing that even employees of the Nazi security apparatus, in particular, but also of other Nazi institutions, had previously been familiar with the ideas of Biodynamics and had shown sympathy and interest in them. So there were significant “rearguard actions” within the system after the ban.

There were also long running conflicts and power struggles within the NS leadership, between for instance the agriculture minister Walther Darré and his line manager Martin Bormann regarding their differing approaches to biodynamic agriculture. The ambitious Bormann, previously the deputy of Hess as well as a friend of the agrichemical and fertilizer industry, had climbed the ranks and saw the day of reckoning coming for Darré and his sympathy for biodynamic agriculture, especially once his deputy the secretary of state Backe, had been demoted.

In the context of the Gestapo action, the only arrests of members of the Biodynamic Society were isolated and mostly short-term. Only the chairman of the Society, Erhard Bartsch, remained in solitary confinement for almost six months. Bartsch's first Gestapo interrogation was not without a certain absurdity. In line with their conspiracy theory that the Anthroposophical Society had infiltrated the party and manipulated Rudolf Hess in particular, the Gestapo interrogators asked pointed questions about contacts with state and party officials in order to incriminate the accused. Bartsch gave a rapid outline of his many contacts with leading National Socialists. In conclusion, he stated that shortly before his arrest, he had received an order from Himmler that an 11.120 acres (18.000 Morgen = 4500 ha=11.120 acre https://derumrechner.de/flaechen/morgen-in-acre/18000/) estate in the “area of interest of KL Auschwitz” was to be taken over and run as a biodynamic farm.

The summer of 1941 when Bartsch was waiting to visit the Auschwitz site, was in the time before the line had been crossed to industrial-scale mass murder. Auschwitz then meant something different to what became inevitably associated with today. And yet we can sense how close Bartsch and biodynamic agriculture came to these criminal dimensions.

Erhard Bartsch, as can be shown by reading his articles and memoranda, did not have any antisemitic views. Nonetheless until the time of his arrest in 1941 – and despite the repression of anthroposophy – he believed in the national socialist state and respected the ‘personality’ of Adolf Hitler. Bartsch was not a national socialist but believed strongly in the German nation.

The absence of antisemitic and racist arguments in the texts of the biodynamic movement does not alter the fact that Bartsch, despite widespread awareness of the persecution of Jews in Germany, did notdiminish his faith in national identity or the NS state. Of course at the time he shared this trust with the vast majority of the non-Jewish population of the Third Reich. This attitude can be better understood if national socialism is considered not merely as an imposed tyranny but – as Frank Bajohr saw it – as a consensual dictatorship and social practice in which the majority of people in German society participated in one way or another.[13]

4. The continued practice of biodynamic agriculture by the SS in the concentration camps and occupied territories

The prohibition of biodynamic agriculture under the terms of the so-called ‘campaign against occult teachings’ was also a specific campaign against the structures left behind by Rudolf Hess. It resulted in the absurd situation of those in the main office of state security being banned from working with biodynamic agriculture while the SS – which was of course part of the office of state security – continued doing so secretly. The ultimate director of both structures was Heinrich Himmler who had gradually accumulated numerous positions in the regime.

Shortly after the disappearance of Rudolf Hess, the most important protector of biodynamic agriculture, Heinrich Himmler stepped in and quietly circumvented the ban. In 1940 he had already established trials to test biodynamic fertilization techniques at his own SS agricultural research institute (DVA). These were set up around concentration camps and were supported by private interests including properties belonging to KZ Ravensbrück. Oswald Pohl and his family lived at Comthurey and Himmler lived with his lover Hedwig Potthast in Brückentin.

It was the prohibition that inspired Himmler to organise a large-scale trial comparing organic and conventional methods on the DVA’s own estates.[14] Some trials took place in concentration camps using prisoner labour and with the confirmed participation of three biodynamic pioneers. The leading members of the now defunct National Biodynamic Society saw the DVA trials as a continuation of the biodynamic trials started by Hess and were then stopped as a result of the ban.[15]

Cooperation with the SS extended over two areas:

I. Work in the concentration camps and occupied territories. This primarily involved the 23 biodynamic holdings run by the SS-Research institute DVA that continued operating without restriction after 1941. These were essentially farms and estates that were operating in and around the concentration camps. The first place that should be mentioned here is Dachau. Organic growing trials mainly of herbs had taken place there since 1939 and it was known euphemistically as ‘the plantation or herb garden’. Despite its harmless-sounding name, this was a place where the most brutal exploitation of prisoners took place. Working in the

research department for organic agriculture were the biodynamic pioneers Franz Lippert and Martha Künzel, and to certain extent Carl Grund.

II. Himmler was interested not only in trying out biodynamic agriculture but also on expanding its reach. Openly promoting biodynamic agriculture or ‘agriculture with a natural lawfulness’ as it was referred to in official circles, was no longer possible in the Third Reich after it was banned in 1941. Since Himmler was nonetheless interested in carrying out further trials he felt that it would be safest to choose a place in the occupied territories of the Soviet Union. The choice then fell on Ukraine and the state property of Vertokiyivka near the town of Schytomyr that had been renamed Wertingen. This estate had been known under the Soviets as a particularly effective agricultural unit for amongst other things, hop growing for which it had received an Order of Lenin award.

The extent to which Himmler came into contradiction with the interests of the various official roles that he had assigned to himself, is revealed by an episode in the hidden Ukrainian research plots in Wertingen. Under the aegis of the SS, biodynamic agriculture continued to be practised by Carl Grund even after it was officially banned. The SS Colonel Henschel was the one responsible in the district of Schytomyr for dividing up the Soviet collective farm and making it available to German settlers. Wertingen lay in that district.

Dividing it up would have made biodynamic management impossible and destroyed for example the already implemented work of planting hedges. The interests of the SS Colonel Theodor Henschel and SS Lieutenant Colonel Carl Grund, a biodynamic pioneer, were in contradiction with one another. Both however received their orders from Himmler. Grund had a better relationship with his boss and made full use of it. Henschel subsequently emphasised in a report that he was well aware that Grund was carrying out banned biodynamic research in Wertingen.[16]

Himmler also made Schytomyr, now called Hegewald, his forward command centre once the Jewish population had been either murdered or deported. It is reported from Schytomyr in particular, that the SS publicly organised the execution of the Jewish staff of the Soviet justice department as popular entertainment.

Hegewald was also one of the SS settlement zones that had been implemented with around 10,000 ethnic Germans who had emigrated to different parts of the Russian empire in the middle of the nineteenth century. In addition ethnic Germans were brought in from the small towns and cities of the Ukrainian uplands. This was an emergency solution since contrary to expectation hardly anyone from Germany volunteered to settle there. At no time were the settlement plans a response to the economic needs of German settlers. This arose solely from the imperialistic and racist fantasies of the SS and NS leadership as is demonstrated amongst other places in the Schytomir city archives.

Carl Grund was particularly active and, together with other biodynamic representatives, travelled extensively through Ukraine and into Crimea in order to identify further sites. Their very unrealistic plans were for up to 50.

5. Membership of organizations classified as criminal, such as the SS

During this study a total of seven members of the National Biodynamic Society were found to have been members of the SS. Even in the latter years of war membership of the SS was a free choice, there was no compulsion for biodynamic people to join. Several biodynamic representatives though, were arrested.

Herbert Beichl, son of the biodynamic farm administrator on the Heynitz estate in Saxony, was recruited as an SS member by the DVA director Heinrich Vogel as SS Colonel ‘F’ in order to manage the biodynamic estates team after the prohibition in 1941.[17] He was not an anthroposophist and had learnt about biodynamic agriculture at the Heynitz estate. Carl Grund, Martha Künzel and Franz Lippert also continued working for the SS after the 1941 prohibition including in concentration camps where the criminal context of their own actions was clearly visible. After his release by the authorities in 1941, Grund was employed by the central SS office for economic affairs and worked for the DVA as SS Captain in, amongst places, the Dachau 'plantation' in Dachau, Comthurey in Ravensbrück and on the research project at Wertingen in the Ukraine. Between 1941 and 1945 Franz Lippert was director of the DVA biodynamic research department at the 'plantation' in Dachau.[18] Martha Künzel was also a director of the DVA biodynamic research department in Dachau between 1942 and 1943.[19] As a woman she could not be a member of the SS but as an employed civilian she was beholden to the SS. Maria Lohrmann, also a pioneer of biodynamic agriculture who had worked as a biodynamic gardener for the women's settlement in Loheland from 1928 to 1934, joined the NSDAP in 1941. She was recommended by Franz Lippert for a post in the (not biodynamic) plant breeding station in Rajsko by Auschwitz. She worked there from April 1943 as a civil employee of the SS but left of her own volition in October 1943.[20]

The NSDAP party official Walter Granzow joined the Experimental Circle of Anthroposophical Farmers in 1932 but left soon afterwards when he was nominated as state president of Mecklenburg-Schwerin. He joined the SS in 1933 and in 1936 became an SS Brigadier. Walter Ritter, an anthroposophist, biodynamic pioneer and director of the information office in Bayern, worked as a member of staff and as estate manager for the biodynamic estates of Köfering and Gebelkofen from July 1923 until 1937. In 1940 he became a clerk in the Bayreuth administrative offices of the Bavarian Eastern Marches Farmers Union and then joined the SS.[21]

There are unfortunately very few autobiographical texts available that might provide an insight into the motivation of the various individuals. Only for Carl Grund are private letters available that clearly demonstrate his critical reflections on the criminal activities taking place in the occupied territories. In his case 'cooperation' was least of all voluntary but it did mean that he was released from Gestapo internment and could continue with his professional work. As women it was particularly difficult for Martha Künzel and Maria Lohrmann to find any kind of research opportunities in the Third Reich that did not have precarious conditions attached. Franz Lippert was surely fascinated by the enormous resources made available to him by the SS. He was the only one who after 1945 had to submit to a denazification process and like the majority of Germans, be exonerated. This enabled him through the documentation of the prisoners – many of whom were Catholic priests – to show that they were fairly and humanely treated by him at his research

department in Dachau. With all of them, there was certainly the desire to ensure that the ideas and practice of biodynamic agriculture would survive and that the structures created would not fall into incompetent hands.

6. The end of the war and the new start after 1945

In 1945 a large proportion of the biodynamic farming estates in eastern Germany were gone due to the loss of land that was previously German, property takeovers and land reform. A new farmers coalition started that was small and confined to the western zones. In August

1946 former members of the Experimental Circle of Anthroposophical Farmers and other interested people were called together in order to discuss the constitution of the Research Association (Forschungsring) for Biodynamic Agriculture which was to be founded in Stuttgart in October. The new name, Research Association, showed that the organizers wanted to avoid a straightforward continuation of the former Experimental Circle. According to early statements,the aim was to not centralise and to consciously avoid having an umbrella organisation. This decision was certainly the result of lessons learnt from the Third Reich – it had after all been the National Biodynamic Society which had engaged with the state and the party. It was believed that by having a decentralised structure the focus would be more individually applied on one's own projects. It was notable too, that neither of the two office bearers in the Third Reich – Erhard Bartsch and Franz Dreidax – were given a specific role in the new organisation. Although there were internal debates, a critical discussion of the Nazi past did not take place. A more public engagement with the Nazi past would only begin in the 1980s.

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[10] These included Dr. Wilhelm Kinkelin, Karl August Rust, Rudi Peuckert, Wilhelm Rauber, Günther Pacyna, Reinhard Ohnesorge and Dr. Wilhelm Driehaus.

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9.3 Method to assess organic, biodynamic, and conventional practices on wine quality and typicality

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Abstract

This study proposes a methodological approach to evaluate the impact of different production processes on Chianti DOCG wine quality. Wines from the 2016 and 2017 harvests were selected based on the type of production management. A survey collected winemaking data to estimate CO_2 emissions. Wines were chemically characterized for standard parameters, polyphenol, and volatile profiles. Sensory analysis defined intrinsic quality and typicality. Organic and biodynamic wines showed lower CO_2 emissions, but statistical analysis found no management-based differences in quality. Expert scores indicated that estate management could affect typicality differently, but all management types could still produce wines consistent with the typicality reference frame. It can be stated that a lower carbon footprint in winemaking does not, in itself, hinder the production of a typical wine.

Background and Aims

The wine industry is currently shifting toward more sustainable production systems. While the viticultural effects of biodynamic and organic practices on wine grapes have been investigated, there is a lack in literature on the general effect on the final quality of wine. The questions we aimed to answer were: Is it possible to achieve the same level of quality and typicality in wine by adopting more sustainable production processes, such as organic or biodynamic methods? Do fewer interventions in the vineyard and cellar pose an obstacle to achieving this goal?

Methods

Commercial organic, biodynamic and conventional Chianti wines from the 2016 and 2017 harvests were collected. A survey to estimate winemaking CO_2 emissions was submitted to the wineries. The global wine quality was analyzed by i) eligibility profile (standard chemical parameters and polyphenols concentration), ii) peculiarity profile (volatile compounds), iii) style profile (characteristics that result from winemaking methods) according to Bertuccioli et al. (2011) and Canuti et al. (2017). A group of 45 experts evaluated the sensory differences between wines by the Napping test and rated their typicality (perceived quality).

Results and Discussion

Organic and biodynamic management showed lower estimated carbon dioxide production levels. No systematic differences were found in the eligibility and identity profiles based on the type of production process. However, significant differences were observed in the phenolic composition and volatile compounds. Specifically, it was confirmed that organic and biodynamic wines were more evolved in terms of color stability compared to conventional wines, according to Parpinello et al. (2019) and Picchi et al. (2020). The SIMCA model, based on chemical and sensory profiles, revealed that the conventional wine model had less variability, while the biodynamic model showed more variability in terms of both intrinsic and perceived quality. Sensory expert ratings emphasized that the estate management process could influence wine typicity differently, but also that any type of management could produce a wine consistent with the typicality reference.

Conclusions

The comparison of organic, conventional, and biodynamic production processes for typical wines provides interesting insights for future research. Based on current knowledge of intrinsic wine quality and the survey conducted, this study offers, for the first time, conclusions regarding perceived quality. It is now possible to state that a lower carbon dioxide emission during the winemaking process does not, by itself, hinder the production of a typical wine. This finding, however, underscores that controlling the process is the key factor in producing a typical wine, regardless of the management type.

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10. Rhythms in Nature and Agriculture

10.1 Dynamic Biosinging: A Voice-Based Approach to Rhythmic and Formative Forces in Biodynamics

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Abstract

Dynamic Biosinging is an experiential method developed at the intersection of biodynamic agriculture, music, and environmental education. It seeks to reconnect human beings with the living world through the conscious use of the voice, breath, movement, and observation of cosmic rhythms. This research explores the transformative effects of this method on individuals and communities engaged in regenerative land-based practices. Using a combination of participatory observation, individual interviews, and group experiences in Brazil and abroad, the study reveals improvements in participants' sense of rhythm, ecological perception, emotional wellbeing, and social cohesion. These findings suggest that Dynamic Biosinging may serve as a valuable artistic-ecological tool to support inner and outer renewal in biodynamic contexts.

Background and Aims

Modern lifestyles, shaped by mechanistic thinking, increasingly separate human beings from the web of natural rhythms, leading to disruptions in both ecological balance and human wellbeing (Capra, 2002; Capra & Luisi, 2014). This fragmentation is particularly evident in how individuals relate to their own voice and breath—two intrinsic, yet often neglected, rhythms of life. Inspired by biodynamic principles, Goetheanism observation, and therapeutic singing traditions, Dynamic Biosinging was developed to support the reintegration of human beings with the greater rhythms of the Earth and cosmos. The aim of this research is to explore how artisticecological singing practices can foster deeper ecological awareness, vitality, and social engagement among practitioners of biodynamic agriculture and education. This study specifically seeks to document the experiential impacts of Dynamic Biosinging on individuals and groups, and to investigate its potential as a method for ecological regeneration through human participation.

Methods

The research followed a qualitative approach grounded in participant observation, experiential immersion, and narrative inquiry. Between 2020 and 2024, workshops, retreats, and group sessions were conducted in rural and urban settings across Brazil, Argentina, Chile, Peru, and several European countries. Participants included farmers, educators, musicians, and therapists engaged in biodynamic or regenerative practices. Each session integrated vocal exercises, breath work, gesture and movement inspired by eurhythmy, and contemplative observation of nature and celestial cycles. Data was collected through pre- and post-activity interviews, reflective writing, and audiovisual documentation. The collected material was analysed thematically, identifying recurring patterns in participants' experiences, transformations, and challenges. Particular attention was given to the embodied relationship with time, place, and inner voice, as perceived during the process.

Results and Discussion

The results reveal that participants experienced increased inner calm, enhanced breathing, a renewed sense of connection with nature, and improved group cohesion. Many reported a deeper awareness of the rhythmicity of life and a sense of belonging to a larger cosmic order. For farmers and land workers, the method encouraged more attentive and reverent practices in their relationship to soil, plants, and animals. Several participants noted emotional release, expanded creativity, and a stronger capacity for listening—to themselves, others, and the environment. The findings align with core insights of anthroposophical and biodynamic thinking, especially regarding the formative forces in sound and rhythm such as "Eurythmy as Visible Speech" (Rudolf Steiner, 1924). At the same time, challenges emerged, particularly regarding initial resistance to vocal expression and the integration of subtle perceptions into daily routines. These indicate the need for a gradual, trust-based pedagogical approach. Overall, Dynamic Biosinging appears to offer a valuable complement to biodynamic practice, promoting both individual healing and communal resonance with living rhythms.

Conclusions

Dynamic Biosinging offers a creative and ecological approach to reconnect human beings with cosmic and earthly rhythms. As a practice rooted in artistic, spiritual, and biodynamic foundations, it supports vitality, awareness, and cooperation—key elements in the renewal of agriculture and community life. This research highlights the method's potential as a therapeutic and pedagogical tool within the biodynamic movement and invites further exploration into how voice and sound can foster regeneration, not only of individuals, but of the living landscapes they inhabit.

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10.2 Element concentration changes in fungi and plant species

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Abstract

During the last and the beginning of the current century changes of element concentration in living plants, fungi and bacteria were reported by several researchers. However, the phenomenon of the so-called biological transmutation remains unclear since its mode of action is not yet understood and not establishable using the current models in physics. Therefore, we measured the potential differences in element concentration during the growth phase of living organisms. Our results indicated that changes in element concentration may occur in fungi and plants.

Background and Aims

Research on a potential change of the concentration of chemical elements in living organisms during their growth period dates back to the 18th century. During the 20th century, Hauschka (1942), Baranger (1960), Kervran (1972), Biberian (2015), and others, observed varying element concentrations in fungi, plants, animals and humans. However, peer-reviewed published research on the change of chemical element concentrations within living organisms in closed systems has been rare in the last decade. An exception is the work of Vysotskii (2015), describing the potential of bacterial consortia to reduce the radioactivity of Caesium-137 by transmuting it to Barium-138. In our current project, we are investigating the phenomenon in baker's yeast (*Saccharomyces cerevisiae*) and garden cress (*Lepidium sativum*).

Methods

The organisms S. cerevisiae and L. sativum were allowed to grow in closed environments. A sample was taken before and after the growth phase. The samples were dissolved with an acidic digestion and the element concentrations of Ca, Fe, K, Mg, Mn, Na, P, and Zn were measured by means of inductively coupled plasma with optical emission spectroscopy (ICP-OES).

Results and Discussion

In several experiment series statistically significant differences and trends could be measured between ungrown and grown organisms. The significant differences in yeast were about one percent. The trends in garden cress reached 5-10%.

Conclusions

Our results indicate statistically significant differences in element concentration and therefore they support the hypothesis that biological transmutation takes place in living organisms. However, uncertainties remain and hence the results must be verified in additional experiments.

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10.3 Cosmic and Biodynamic Influences on Soil and Compost Quality

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Abstract

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Background and Aims

Based on the observations from the 2nd Conference, we aimed to achieve the optimal timing for plant growth with the application of BD preparations.

Based on the actions of the cosmos, this occurs in winter. We took soil samples to see the record of this moment in the chromas.

R. Steiner (1924), GA 237, 2nd Lecture

… as January (winter) comes to an end, the mineral substances of the earth have their greatest yearning to be crystallized, and the deeper one goes, the greater is that yearning to become crystallinely pure within the context of nature……

…at this point, plants are more than ever completely self-sufficient and exposed to mineral substances to the least extent; however, for some time before and after—especially before, just as the minerals are about to become crystalline—they radiate forces that are especially important for plant growth….

...What is captured from the cosmos from below must always be able to flow upwards…

…it is during this time that the greatest crystallization power, the greatest formative force for mineral substances, can develop within the Earth. This occurs in winter. It is when the Earth depends less on its own mineral masses and falls under the influence of the morphogenetic forces of the crystalline, forces that are found in the far reaches of the cosmos…

Methods

I found a sensitive method that expresses the farmer's process through the application of biodynamic preparations to the soil and their food.

The sensitive method used is Pfeiffer Chromatography:

Horizontal capillary dynamometer. Pfeifer was developed based on the biodynamic calendar and the annual rhythm of nature: month, day, time, and constellations (See Annex 1; SAMPLING PROTOCOL FOR Pfeiffer's HORIZONTAL DYNAMOLYSIS ANALYSIS)

A dilution table was respected to make the chromas, the running times in all the soil, compost and food samples, so that they are comparable (Table 1)

Samples were taken before and after each application.

The method for saving and identifying chromas for later scanning was established. The idea is to create a database for consultation by biodynamic farmers and others interested in the subject.

A record was made of the biography of each organization/farmer in relation to the cr

Results and Discussion

A- It was gratifying to hear the stories of the organization members during the chroma sampling; their changes in attitude, the harmony that existed, could be seen in the group, and their manifestation was also reflected in the chroma.

Chroma, as Norma Priemer, our teacher of sensitive methods, told us, reflects a process; it showed us a trace.

B-Sensitive methods record intentions and display them in different areas of the chroma. This method of recording intentions was conceived for areas where before-and-after sampling was conducted, without applying or spreading preparations, simply applying the farmer's intentions.

It was observed that the area of the farm NOT applied with preparations presented in the soil chromas, the same light features, the same integrated areas, the radial axes in the form of a feather, the volcanoes spilling humus similar to the chromas of the areas where preparations had been applied.

To challenge ourselves, we did it on two farms approximately 12 km apart, and the same thing was also recorded. The area where the first intention was made without application suffered a fire surrounding it. The fire did not penetrate, only scorching the sides of a group of trees. We have photos of how those trees sprouted, even with part of their bark burned, in a very vital way, surprising us once again.

Conclusions

The applications made in Christian Festivals have an effect on the soil, and also on the conscious Soul of the farmer and his environment , its manifestation observable in the chromas when analyzing the biography.

This allowed us to open our listening, to feel the value of Brotherhood properly understood, to see the Divinity hidden in the other, and to reach the spirit through thought and thereby achieve a spiritual Experience.

Admiration for the work done by others.

A community of biodynamic farmers is in the making, where research work is everyone's responsibility.

The research was a way to support farmers, allowing them to verify, through the records kept by the chromas, what their intentional work was achieving for the soil and their food.

To do this we put together a Power Point to show the chromas.

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R. Steiner (1924) GA 327 Agriculture Course

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Biodynamic Calendars 2019 to 2025

EE Pfeifer (1963) Chromatography, applied to quality analysis.

“Anthroposophy is a path of knowledge, understanding that would like to lead the spiritual in the Human being towards the spiritual in the Universe” R. Steiner

"The task of agriculture is to transform mobile solar energy, light energy, into the inner force of food for human beings. Light is the basic raw material of the agricultural industry."

ANNEX 1: SAMPLING PROTOCOL FOR Pfeiffer's HORIZONTAL DYNAMOLYSIS ANALYSIS

SOIL SAMPLES

- Reconnaissance tasks, comprehensive diagnosis of the plot.

- Biography of the farmer, his family and the farm organization, age and commitment of the people who perform the tasks, applications of biodynamic treatments (dates and times), and everything that allows us to understand the history of the place over the last 5 years.

- Photographic documentation of the phenomenology, profile, vegetation cover and cultivation on that soil.

- During extraction, document odor, color change, humidity, microfauna, roots (distribution, abundance and/or lack of them), the structure and type of aggregates they present.

- Drainage, irrigation, frequency, periods of drought, flooding, high water tables, presence and aroma of mushrooms.

- Date of the last irrigation close to the sample collection

- Plant biodiversity, crop associations, presence of bees, birds, rodents, animal grazing. Natural grassland.

- Crop rotation

- Livestock management, with crop residues, fallow land, etc.

- Historical and current information related to chemical inputs, foliar fertilizers, bioles, contributions of uncomposted guano, burning or fires within and around the organization, etc.

<u>Soil sample extraction:</u>

In the first sampling, a sample is taken from the zero point, a place where no cultural intervention or applications were ever carried out, e.g.: a fence corner or a place indicated by the farmer.

Depth, 30 cm, except in cases where greater depth is indicated.

Identification: each sample must have the date, time, farmer, and location where it was taken within the organization, according to SPG's sketch.

Collect on the day of the ROOT, during the waning moon, when the earth inhales after 3 p.m. Approximately 200 to 300 grams.

COMPOST SAMPLES

- Farmer's biography, materials used and their origin; check if the six biodynamic preparations were applied for closure; humidity; if there are periods of drought; if there are high temperatures above 60 degrees Celsius (approximately for how long); if there is a lack of cover; and if the area is open, with or without protection.

- Date of completion of production, if there were any subsequent applications of preparations or turning.

Extraction of the compost sample:

It is obtained from the middle section, between 30 and 50 cm deep, after uncovering it and removing the covering. Indicate any details on the label that might be of interest, such as excessive dryness, unpleasant odor, excessive moisture, etc.

Leave it covered again in the compost, after removing the 300 gram sample.

FOOD SAMPLES

Biography of the farmer, the production of these foods, and their processing if they were processed. Application of biodynamic preparations during their development and ripening.

Depending on the type of fruit and food, we must consider the right time for harvesting or processing. To show us their best properties and quality, these are evident in the images.

Extraction of the food sample:

Produced under the surface, remove ROOT day after 15 hours , descending moon

Produced on the surface, remove the FRUIT day, in the morning when the earth exhales. On the ascending moon.

Seeds, FRUIT day: In the morning, remove from the middle of the ear or corn cob. This requires at least three seeds. To grind 15 grams, remove during the ascending moon.

Honey, FRUIT day, ascending moon in the morning

Flowers, Pollen on a FLOWER day, minimum 3 grams. Rising moon tomorrow.

Honeycomb. Wax day of ROOT at least 10 grams. Descending moon

Leaves and stem, LEAF day, ascending moon tomorrow, minimum 9 leaves from the center, bottom and top of the plants and/or trees.

KEEP IN MIND:

- do not take samples on a Node or eclipse day.
- in new bags without contact with bad odors or chemicals.
- use clean tools for extraction.
- contamination-free gloves.
- always label everything, avoid getting it wet and use ink that doesn't run.

-processed foods, removing them at each stage of the process and the final product.

- Tags: date, time, farmer, location, highlighting any details worth considering, for example, a weather event or the application of a preparation as an offering for the Three Kings. Noteworthy features such as a mushroomy smell, compacted soil, excessive worms, etc.

11. The Ecosystem and Environment

11.1 Biodynamic Agriculture and Autonomy: Sustainability Analysis of Soil Management

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Abstract

Biodynamic agriculture represents an agricultural approach that integrates ecological and spiritual principles to promote sustainability and soil and plant health. This study focused on the JANUS project, located in the Patagonian Alto Valle, Argentina, which implements biodynamic practices to autonomously manage soil fertility. Using the LUME method, the study evaluated how JANUS minimizes dependence on external inputs through composting and biodynamic preparations. Results showed that JANUS exhibits a higher Soil Quality Index compared to conventional and organic systems, characterized by its high organic matter content and microbial diversity. The achieved autonomy reduces vulnerability to market fluctuations and ensures resilience against environmental stresses. This study underscores the importance of Biodynamic Agriculture in promoting sustainable and autonomous agricultural systems.

Background and Objectives

Biodynamic Agriculture creates a self-sustaining and balanced agricultural organism by working harmoniously with nature (Dussi et al., 2020; Koepf et al., 1983; Vargas et al., 2020). This configuration is based on the conservation of the vitality of the environment and its productive capacity, through the dynamic balance between nutrients and energy flows, minimizing external inputs and outputs to the agroecosystem (Steiner, 2010). In this way, it can significantly influence the sustainability of the agricultural organism in relation to soil fertility management.

Thus, this study aimed to determine whether the implementation of biodynamic practices contributes to improving soil fertility and promoting agricultural autonomy.

To this end, data from previously conducted physico-chemical analyses on soils under conventional, organic, and biodynamic management were used, and, focusing on the biodynamic agricultural organism in question, the soil fertility indicators present in the Autonomy Index of the LUME method were examined.

Methodology

The study was carried out on a biodynamic farm, JANUS Proyecto Rural Integrador, located in Contralmirante Cordero, in the province of Río Negro, Patagonia, Argentina (Figure 1). This farm has been developed on the foundations of Biodynamic Agriculture for the past 15 years, since its owners purchased an abandoned conventional farm (Janus, 2025).

Figure 1 - Location of the JANUS agricultural organism

Source: Authors' personal collection, adapted from a printout made using the Google Maps tool.

Thus, to address the proposed objective, three main qualities of the soil were considered: chemical, physical, and biological. The data for this analysis were obtained from research conducted by Buganem (2017). The author carried out this study on three farms located in different towns in the provinces of Neuquén and Río Negro, in the Alto Valle region, with JANUS being one of them. For this, she used descriptive and variance analyses to process the data, as well as various indexes to characterize the studied variables.

On the other hand, we used the analytical method of Petersen et al. (2025), the LUME, to investigate the soil fertility parameters at JANUS. This analysis focused on input management strategies necessary to maintain the regeneration of soil fertility. Data collection was carried out through questionnaires and direct and participatory observation.

Results and Discussion

Regarding the physico-chemical characteristics of the soil, the study compared a biodynamic farm, an organic farm, and a conventional farm (Figure 2): Regarding the physico-chemical characteristics of the soil, the study compared a biodynamic farm, an organic farm, and a conventional farm (Figure 2):

Figure 2 – Comparison of the physico-chemical characteristics of the soils of the studied farms

Fruit Orchards of the Alto Valle of Río Negro and Neuquén			
Characteristic	**Biodynamic**	**Organic**	**Conventional**
Texture	Loam-Silt	Loam-Silt	Loamy-Sand
pH	7.86	7.60	6.55
Conductivity (dS/m)	0.60	1.00	0.30
Organic Matter (%)	4.60	3.21	2.63
Organic Carbon	2.68	1.87	1.53

Source: Adapted from Buganem (2017)

As can be seen, higher values of organic matter and organic carbon fixation were obtained in the biodynamic farm. This has a major influence on the biological characteristics of the soil.

Buganem (2017) also analyzed the richness and diversity of functional groups of microorganisms, divided into three groups: phosphorus solubilizers, nitrogen fixers, and cellulolytic organisms.

JANUS showed a greater number of total bacterial morphotypes, phosphorus-solubilizing microorganisms, and cellulolytic microorganisms, therefore, a greater specific richness.

We analyzed this information using the LUME method, investigating the practices, origin, and flow (Figure 3) of the inputs consumed at JANUS.

JANUS adopts the integration of practices such as crop rotation and the use of the biodynamic calendar. Thus, its fertility is managed in harmony with natural and astronomical rhythms.

Moreover, the impetus to promote plant and soil health through planned or spontaneous plant and animal diversity was verified, which reduces the need for external inputs to the agroecosystem.

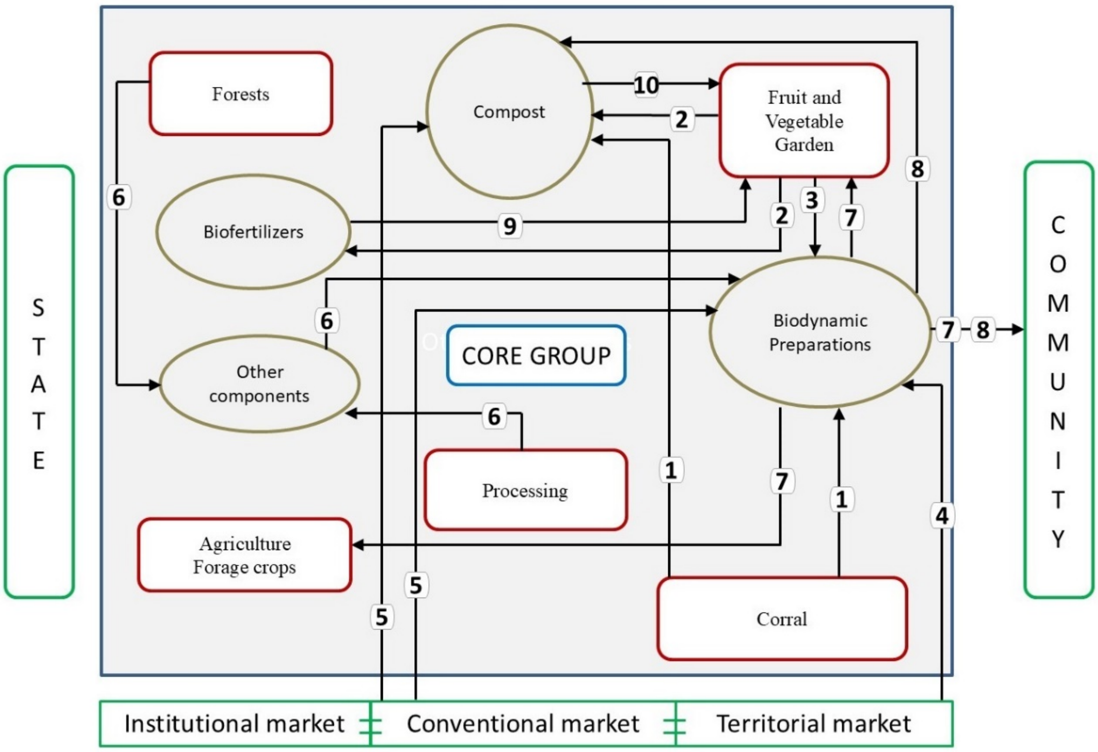
A complex organization of inputs is also observed, resulting in low dependence on external inputs, which are only of mineral and animal origin, necessary for the production of biodynamic preparations.

Thus, in terms of autonomy, JANUS's biodynamic management ensures that most of the nutrients are supplied from within the agricultural organism itself, reducing its vulnerability to market fluctuations, inflation, and input scarcity.

Conclusions

In conclusion, the results of the soil analysis at JANUS, combined with the input flow from the agroecological analysis method LUME, demonstrate a management approach whose practices generate excellent biological qualities in the soil while increasing its fertility, promoting the long-term sustainability of the agricultural organism, and autonomy in its maintenance. The biodynamic worldview, which sees the farm as a living organism, fostered the promotion of regenerative practices that strengthened the health and resilience of the agricultural organism in the face of environmental stresses, while reducing the use of external inputs, demonstrating the potential of Biodynamic Agriculture to design healthy, resilient, and autonomous agroecosystems.

Figure 3 - Input flow at JANUS



Legend: 1 – Manure; 2 – Plant residues (green and dry); **3 – Plants used in Biodynamic Preparations:** Achillea millefolium; Matricaria chamomilla; Urtica dioica; Bark of Quercus robur; Taraxacum officinale; Valeriana officinalis; Equisetum arvense; **4 – Animal-derived inputs for biodynamic preparations:** Horns; Deer bladder; Bovine intestine and mesentery; Skull of a domestic animal; **5 – Mineral inputs:** Silica; Basalt; Diatomaceous earth**; 6 – Other inputs:** Eggshells; Wood ash; **7 – Biodynamic Preparations:** 500, 501, 508 – Fladen; **8 – Compost Preparations:** 502 to 507**; 9 – Infusions, Decoctions, and Macerations; 10 – Compost.**

Source: Authors

Acknowledgments

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11.2 Cloud Forest Recovery: Endemic Species, Agroforestry and Scientific Inquiry of Emerging Plants

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Abstract

Cloud forests in the Western Hemisphere, 90% deforested since the 1970s, are facing virtual extinction by 2060. The research focuses on agro-native forestry for cloud forest restoration on lands eroded by cattle farming, a principal cause of cloud forest destruction. Only native species are planted, prioritizing at risk of extinction and edible or medicinal tree species. The project incorporates the biodynamic concept of a self-sustaining ecosystem to promote forest recovery. Initial site evaluations included orthophotography mapping of pilot plot areas and identification of native and edible species for planting. The first three years of data show that reforestation exclusively with endemic species accelerates cloud forest recovery vis-a-vis rewilding, with abundant emerging growth and positive wildlife response. Results suggest a symbiotic relationship between planted trees and emerging growth, likely involving arbuscular mycorrhizal fungi, which together with experimental mulching practices accelerate suppression of introduced pasture grasses.

Background and Aims

Cloud Forest Organics (CFO) is a reforestation site in the Andean Amazon of Ecuador. CFO also serves as a buffer zone to the adjacent primary forest of the Cayambe Coca National Park. Previously owned by a cattle rancher, in 2012 the CFO 170-acre farm was 52 percent deforested, with 48 percent of primary and secondary forest remaining.

The project site is home to Crystal Frog, an ecologically constructed research center whose aim is developing methodologies and hosting researchers for cloud forest recovery. This includes best practices for propagating, planting and stewarding endemic species, while testing and experimenting with culinary, cosmetic and medicinal potential of forest-borne foods and ingredients.

CFO is a self-sustaining ecosystem with no external fertilizers, trees or crops. Endemic trees with nutritional value are planted without restricting emerging wild flora and fauna, to respect the natural symbiosis of wild forests while providing opportunities from productive native species (Andres et al., 2023; Dorner Jeanette, 2002).The hope is to offer verifiable alternatives to agroforestry models that rely on non-native commercial species such as coffee.

Methods

The study contemplates five test plots. Plots 1 and 2 are agro-native forestry plots that include trees with nutritional potential and species at risk of extinction. Plot 3 is a rewilding control plot with no planting or intervention. Plots 4 and 5 are iterations recently planted based on observations from Plots 1 and 2 over the last 3 years. More information on methods will be available in the upcoming publication "Reforestation Strategies Applied to Montane Cloud Forest: Key Findings and Techniques." - (Maldonado Andrea, Leon Craig, Torres Vicente).

This study is carried out in stages, some done simultaneously:

1. Understanding of site: topographic, hydrological, and plant coverage mapping, soil sampling, water pH testing, quick survey of existing plant species.
2. Identification of native, at risk of extinction and edible species: *Erythrina edulis, Juglans neotropica, Pouteria sp.1 and sp.2, Ceroxylon sp., Cedrela sp.1 and sp.2, Ocotea sp., Hieronyma duquei, Nectandra membranacea, Croton lechleri, Myrcianthes sp., Persea sp., Guarea kuntiana.*
3. Planting: fertilization using compost and organic matter from the forest.
4. Maintenance: invasive honey grass controlled using mulch and mechanical tools.
5. Monitored variables: height (cm) and diameter (mm).
6. Scientific visits and field cameras to study flora and fauna.
7. Field and meteorological data are collected periodically.
8. Observation and culinary experimentation with cloud forest plant species.
9. Analysis: using data collected over 36 months, analyzed using Excel as data encoder and Origin software for data analysis of mortality and graphing.
10. The literature review described in this document was conducted using scientific article databases.

Results and Discussion

Initial results suggest that fertilization may be unnecessary or even counterproductive, as excessive growth in some species (e.g., *Erythrina edulis, Croton lechleri*) caused stem splitting. Regeneration of species damaged by wildlife is tentatively linked to mycorrhizal activity based on (Haug et al., 2010). Notably, *Juglans neotropica*, *Ceroxylon sp.*, and *Cedrela sp.* showed the best performance in growth and resilience. (Maldonado et al., 2025)

Test Plots 1 and 2 exhibit a high abundance of emerging edible and medicinal plants such as *Clinopodium sp.* (sunfo), *Solanum quitoense et al.* (naranjilla), *Chilca*, *Nasturtium sp.* (watercress), *Rumex sp.* (bitter dock), and *Piper aduncum* (spiked pepper). This spontaneous regeneration suggests a possible symbiotic mechanism between planted species, emerging flora, and soil fungi. Some edible species, like *naranjilla*, emerged spontaneously, raising questions about ecological memory, forest intelligence (Greenhalgh, 2022) and the role of wildlife in forest recovery according to (Estrada-Villegas et al., 2023).

Height Growth Rate of Trees in PLOT #1				
Data sampling start:29/07/2021 end:27/06/2024				
Scientific Name	Common name	Average Seedling Height (cm)		Growth Percentage (2021–2024)
		2021	2024	
Erytrina edulis	Poroton	19,5	91,26	368
Pouteria sp.	Lucma	21,74	107,22	393
Juglans neotropica	Nogal	27	208,07	671
Croton lechleri	Sangre de drago	35	589,8	1585
Ceroxylon sp.	Palma de cera	8,75	93	963
N. membranacea	Canelo	18	81	350
Myrcianthes sp	Arrayan	17,5	36	106
	Overall Average	22	195	634

Table 1. Data of height growth rate from Plot 1

Wildlife observations using field cameras show increased activity, as shown in Figure 1: *Dasyprocta fuliginosa* (agoutis) and *Cuniculus taczanowskii* (mountain pacas) interact with planted trees, feeding on bark with medicinal properties, suggesting wildlife is integrated into the recovery process. In contrast, natural regeneration in the control plot progressed more slowly, with vegetation advancing primarily from the perimeter toward the center.

Height Growth Rate of Trees in PLOT #2				
Data sampling start:23/07/2021 end:27/06/2024				
Scientific Name	Common name	Average Seedling Height (cm)		Growth Percentage (2021–2024)
		2021	2024	
Erytrina edulis	Poroton	19	127	568
Pouteria sp.	Lucma	18	94	422
Juglans neotropica	Nogal	23	253	100
Hyronimia duquei	Motilon	42	239	469
Cedrela sp.	Cedro rojo	25	315	1160
Croton lechleri	Sangre de drago	24	538	2142
Ceroxylon sp.	Palma de cera	29	135	366
G. kunthiana	Logmillo	21	39	86
Ocotea sp.	Aguacatillo	27	156	478
Cedrela sp.	Cedro blanco	32	332	938
N. membranacea	Canelo	22	86	291
	Overall Average	26	210	720

Table 2. Data growth rate from Plot 2.

Growth patterns varied by species, supporting the need to respect different development timelines shown in Tables 1 and 2, where the overall growth rate differs for each species. For instance, *Croton lechleri* shows a rate over 2000%, or 20 times its initial transplant height, in 36 months. Mycorrhizal fungi, particularly arbuscular types, may play a key role, supported by literature (Tawaraya & Turjaman, 2014) and initial DNA analysis of soil mycelium in 6 distinct test plots such as is reported by (Storchenegger Anna, 2025).

Figura 1. 1A, 1B, 1C from Plot 1. 2A,2B,2C from Plot 2. (1A. *Dasyprocta fuliginosa* - Black agouti) (1B. *Nasua nasua* - Amazonian coatí) (1C. *Herpaiulurus yagouaroundi* - Jaguarundi) (2A. *Mazama rufina* - Red brocket deer) (2B. *Eira barbara* - Tayra) (2C. *Cuniculus taczanowskii* - Mountain paca/Guanta). (Photos: Dario Morales, 2025)

Finally, the project does not follow traditional agroforestry layering as the study (Webber Simone, 2022) suggests. Instead, a simplified, low-intervention model is used: selected native trees are planted, spontaneous growth is encouraged, and promising species are studied and sometimes propagated. This agro-native forestry model may offer a biodiversity-driven alternative for restoring degraded cloud forest ecosystems (Msikula, 2024).

Conclusion

Cloud forests, now 90% gone, are facing extinction by 2060. The study seeks to find and develop alternatives to current bioeconomy models that prioritize commercial crops like coffee but fail to respect wildlife habitats or support cloud forest recovery. The research focuses on cloud forest restoration through agroforestry test plots of only native species, aiming to develop replicable systems for the Andean Amazon and globally. Early findings show low mortality with varied species-dependent growth rates, significant emerging plant growth, and a positive wildlife response. Data also suggests that endemic arbuscular fungi activity is a factor influencing forest growth. Moreover, data shows that unassisted reforestation, or rewilding, is slower and lacks key species. An agro-native forestry system where no external crops are introduced, consistent with Goethe's and Steiner's core philosophical foundation of a self-sustaining ecosystem, could lead to a deeper understanding and new applications of biodynamic agriculture that support cloud forest recovery.

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11.4 Biodynamic vs. Monoculture Farming: A Comparative Study in Macadamia Cultivation

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Abstract

Preliminary results from a baseline study compared two contrasting Macadamia integrifolia agroecosystems in Quindío, Colombia: a biodynamic-regenerative model (Sorrento Farm) and a conventional monoculture (El Alba Farm). Six randomized blocks were established per farm, with georeferenced plots for trees, shrubs, and herbs. Weed biodiversity was analyzed using ANOVA, multiple range tests, and cluster analysis, alongside soil quality parameters such as bulk density, infiltration rate, aggregate stability, weed biomass, and root development. The biodynamic system showed higher weed species richness (42 vs. 5), greater biomass, and better root growth, which correlated with improved soil quality—lower bulk density and higher infiltration rates. These initial findings suggest that regenerative biodynamic practices enhance plant diversity and soil health, supporting sustainable macadamia production.

Background and Aims

Conventional monoculture agriculture often leads to biodiversity loss and soil degradation (Oakley & Bicknell, 2022), while regenerative models can improve ecological conditions (Furey et al., 2021). Studies show that biodynamic farms typically achieve higher soil quality, aggregation, and ecosystem functionality compared to conventional systems, despite slightly lower yields (Reganold, 1995; Massaccesi et al., 2020; Morrison-Whittle et al., 2017). Biodynamic agriculture, as the oldest organic certification system (Paull & Hennig, 2020), uses composting, green manures, and preparations that enhance soil properties and biodiversity (Mäder et al., 2002; Rodas-Gaitan et al., 2022). Root diversity, organic matter decomposition, and soil aggregation are key for healthy agroecosystems (Gould et al., 2016; Primavesi, 1984). Conservation practices and vegetative cover also help sequester carbon and build soil life (Massaccesi et al., 2020; Kaye & Quemada, 2017). This study aims to assess how two macadamia production models differentially impact agroecosystem biodiversity and soil quality.

Methods

The study was conducted on two macadamia farms in Quindío, Colombia: Sorrento (biodynamic, polycultural) and Del Alba (conventional, monocultural). Both sites share similar Andisol soils, climate, and biome, enabling robust comparison. Six randomized blocks were established per farm. Plots of 10×10 m (trees), 5×5 m (shrubs), and 2×2 m (herbs) were georeferenced to record plant diversity and structure. Biodiversity was quantified through species inventories in all plots, following protocols used in previous agroecosystem studies (Massaccesi et al., 2020; Morrison-Whittle et al., 2017).

Weed and root biomass were measured using standard methods for biomass assessment (FAO, 2013). Soil quality was evaluated by measuring bulk density, infiltration rate, and aggregate stability, following USDA (2019) protocols. Georeferenced data and orthophoto-mosaics (acquired via drone and GPS) enabled spatial analysis of plant and landscape structure.

For statistical analysis, normality and homoscedasticity were checked. When assumptions were violated, non-parametric tests (Mann-Whitney U, Kruskal-Wallis) were applied. For soil variables that met assumptions, ANOVA and Tukey HSD were used. Multivariate analysis of community composition was conducted via Bray–Curtis dissimilarity, hierarchical clustering (UPGMA), and PERMANOVA using adonis2() in vegan (Oksanen et al., 2023). All analyses were conducted in R 4.2.2.

Results and Discussion

This preliminary study compared two contrasting macadamia farms to explore the effects of management on weed biodiversity and soil quality. Sorrento Farm (biodynamic-regenerative) consistently showed higher species richness and Shannon diversity (median richness = 4; H′ = 0.66) than Del Alba (conventional; median richness = 3; H′ = 0.00). Cluster analysis confirmed greater diversity and balanced species cohabitation in Sorrento, with no single species dominating, indicating complex and stable plant communities. In contrast, Del Alba's low diversity was compensated by a higher abundance of a few species occupying large areas, reflecting ecosystem simplification under monoculture.

Soil quality indicators also revealed important differences. Sorrento had lower bulk density (<1.2 g/cm^3), faster infiltration (mean 3.8 min), greater herbaceous biomass (1630 g/m^2), and longer root systems (median 25 cm), all statistically significant, compared to Del Alba (bulk density 1.3 g/cm^3, infiltration 4.4 min, biomass 490 g/m^2, root length 15 cm). These findings align with international studies (Massaccesi et al., 2020; Mia et al., 2021) that associate regenerative and biodynamic practices with improved soil structure, higher carbon inputs, and greater microbial and invertebrate activity.

Both farms showed similar, moderately high aggregate stability, likely due to their Andisol soil type. However, Del Alba's greater compaction and reduced infiltration suggest negative impacts from mechanized weeding and low weed cover. Notably, Sorrento's use of rotational grazing did not result in higher compaction, likely due to diverse ground cover and integrated management. These results support the hypothesis that diversified, regenerative management can sustain higher biodiversity and soil quality—even under similar soil and climatic conditions.

These findings are preliminary, based on only two farms, and broader studies are needed to validate and generalize these trends.

Conclusions

This preliminary study suggests that macadamia cultivation under biodynamic-regenerative management enhances soil quality, biodiversity, and system complexity compared to monoculture. Sorrento Farm showed higher species richness, greater root and biomass development, and improved soil structure. Conversely, Del Alba's conventional practices resulted in lower biodiversity and poorer soil indicators. These findings highlight the importance of diversified management for sustainable macadamia production. However, as only two farms were studied, further research across more sites is needed to validate and generalize these results.

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12.2 Finding the Individuality of Your Farm

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Abstract

In the agricultural course Rudolf Steiner mentioned several times the term "individuality" in connection with a farm. There have often been questions about how to understand this expression. To find out about the characteristics of the individuality of a farm the farmers should do research themselves, on their own farms. We as researchers can only help to do so by asking questions and stimulating, collecting, and comparing observations, also by bringing them into the picture. For this purpose, we created a so-called "journal - farm individuality" which is a kind of a diary, structured like a calendar. Each month is dedicated to one subject, such as the soil, the history of the farm, the animals, the relations etc. and each month is divided into four weeks which are dedicated to the aspects: "inspiration", "observation", "reflection", and "action". The participating farmers are asked to dedicate at least one hour per week during one year to fill that diary. They get paid for that work. 39 farms and 51 farmers are participating. This work started within a workshop in September 2024. During that year four online-meetings are regularly taking place to exchange on the subjects and discuss on how the work is developing. In September 2025, there will be a collection of the outcomes during another workshop with all participating farmers. As a second step, the diaries will be analyzed with the feedback to harvest the insights for developing a second, further developed diary for educational publication purposes. Additionally, the research method of utilizing such a “diary” for investigating the farm individuality will be assessed.

Background and Aims

That study aims at finding ways to support farmers in their personal in-depth research for the individuality of their farm and so, to perceive the holistic character of their agricultural practice. The research is at an early stage. The project team developed the research journal in early 2024 and presented it in a workshop September 2024. Since then the participating farmers have worked individually on the site of their farms. The project team accompanies them through online meetings and some in-person visits.

Methods

The method is based on a guided observation and reflection diary, filled individually on 39 participating farms. Each month is dedicated to a subject. Each week of the month contains a suggestion for exploring the subject from a particular perspective: inspiration, observation, reflection, and action. After one year, the handwritten journals will be analysed by the project team; the research method of using such a journal for investigating a farm's individuality will be assessed.

Results and Discussion

As the whole project, its research method and approach are process-based and in constant development, the outcome of this research will be measured in a collection of personal experiences. The question will be whether it is possible to find generalisable assumptions or methodological approaches which can be applied in any possible situation. Our project looks more at multiple ways to enhance personal perception, and sensibilise farmers for the concrete impact this might have on their agricultural practice. The most important results will contain the farmer's reactions and reflections to that work of one year: did they get closer to their farm individuality than before? Is this method reasonable and functional within their daily practice? As this project reached already in its very early state a wide audience and received a lot of positive feedback, we realised how important it is for farmers to talk about their relationship to their farm and all it includes.

Conclusions

Depending on the reactions of the participating farmers we will ameliorate or change the idea of the diary to detect the characteristics of a farm's individuality. If that concept is successful we will write an update and recommend it to farmers in all countries.

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