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The Coexistence of Multiple Worldviews in Livestock Farming Drives Agroecological Transition. A Case Study in French Protected Designation of Origin (PDO) Cheese Mountain Areas

Patrice Cayre ^{1,*}, Audrey Michaud ², Jean-Pierre Theau ³ and Cyrille Rigolot ⁴

¹ Agriculture Ministry, Reserach and teaching general direction, AgroParisTech, 9 avenue Blaise Pascal, 63171 Aubiere, France

² Université Clermont Auvergne, INRA, VetAgro Sup, UMR Herbivores, F63122 Saint Genès Champanelle, France; audrey.michaud@vetagro-sup.fr

³ AGIR, Université de Toulouse, INRA, F-31326 Castanet-Tolosan, France; jean-pierre.theau@inra.fr

⁴ Université Clermont Auvergne, INRA, VetAgro Sup, UMR Territoires, F63122 Saint Genès Champanelle, France; cyrille.rigolot@inra.fr

* Correspondence: patrice.cayre@educagri.fr

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Abstract: Livestock systems contribute significantly to environmental issues and need to undergo an agroecological transition. This transition is not only technical, but also involves an evolution of farmers' ways of seeing and interpreting the world, i.e., worldviews. We investigate livestock farmers' worldviews and their relationships with farming practices (grazing and mowing management) in three Protected Designation of Origin (PDO) cheese areas in the French mountains. The study is based on quantitative and comprehensive qualitative surveys in 37 farms. We identify entities typically considered by farmers and the kind of relations they have with these entities, as well as the ontological background, sources of knowledge, and worlds of justifications. Four ideal-typical worldviews emerge: Modern; Traditional; Ecological Intensive; Holist. These four worldviews coexist in each area and also at the farm scale. Three selected farmer monographs illustrate this complexity in detail. The four worldviews are consistent with other typologies in literature. Both Ecological Intensive and Holist worldviews can be considered as "agroecological"; however, they correspond to very different conceptions of agroecology. Different worldviews imply different sustainability indicators and pathways, as well as alternative knowledge-management systems. Finally, the coexistence of multiple worldviews is a key driver of the agroecological transition, which can be enhanced by facilitating confrontation and exchanges between worldviews.

Keywords: livestock farming system; worldview; agroecology; transformations; sustainability; dairy system; grazing system; foraging system

1. Introduction

During the second half of the 20th century, agricultural yields and food production in Western Europe increased tremendously. Yet, in the last decades, agricultural activities have also increasingly contributed to numerous environmental issues [1]. In particular, the livestock sector globally currently uses 30% of the Earth's land, 32% of water, and contributes 18% of greenhouse gas emissions [2]. Livestock farming also contributes to several other key environmental issues, such as eutrophication, land degradation, deforestation and associated biodiversity losses [3]. The contribution of livestock systems to ecosystem services and disservices is highly specific, depending on regional

characteristics. In Western Europe, there is a large diversity of contexts, from very intensive to extensive animal-production areas, the latter often associated with quality labels [4]. In European mountain areas, livestock farming contributes significantly to biodiversity aspects, either positively or negatively, depending on management practices [5,6]. The ecological crisis calls for a major transition towards more sustainable practices in livestock farming systems.

In the search for sustainable pathways, the term agroecology has increasingly come to the fore [7]. Agroecology has been defined as a scientific discipline, a movement and a practice [8]. The initial focus of agroecology was to better integrate ecological processes in agricultural systems. According to Stassart [1], the scope of agroecology evolved from this initial focus to the consideration of broader socio-ecological processes, including both ecological and human dimensions [9]. Following this evolution, it is now increasingly acknowledged that agroecological transition is not only a technical matter, but also involves evolutions of values, knowledge systems and networks [10,11]. Moreover, the agroecological transition refers to the adoption of farmers' practices based on on-farm biological processes, in sharp contrast with the idea of modernization, which aims at the stabilization of environmental conditions and living processes through technical and chemical inputs [12]. The substitution of these inputs by ecological processes implies social processes, as described by Demeulenaere and Goulet [13].

On a deeper level, modernity has been associated with an ontological divide between nature and culture [14], as well as specific worlds of justifications [15]. According to Bonneuil and Fressoz [16], the modern way of seeing and interpreting the world is responsible for the current ecological crisis and sustainable pathways require the development of alternatives. This idea can be expressed through the concept of worldview, defined as a "structuring system of meaning, informing how humans interpret and co-create reality" [17]. In a different research community, some authors have developed a complementary evolutionary approach of worldviews [17,18], which has been applied to agricultural transformations in Rigolot [19]. In this literature, four major types of worldview have been identified: Traditional; Modern; Postmodern; Integral [18]. These four types can be seen as successive stages of individual and collective development, although no type can be considered as intrinsically "better" than another [17].

In the agroecological literature, publications began to consider livestock systems only very recently, compared to cropping systems [7,20]. As in the agroecological field more generally, the initial focus was rather on the ecological dimension. For example, the seminal paper of Dumont et al. [20] considers five agroecological principles for the design of sustainable animal production systems: (i) adopting management practices aiming to improve animal health; (ii) decreasing the inputs needed for production; (iii) decreasing pollution by optimizing the metabolic functioning of farming systems; (iv) enhancing diversity within animal production systems to strengthen their resilience; and (v) preserving biological diversity in agroecosystems by adapting management practices. Later, Wezel and Peeters [7] extended this approach to include social dimensions, such as knowledge and social relations. However, only a few studies have investigated values and value changes in the agroecological transition in depth, and again firstly for cropping systems [21]. Interestingly, however, Fleury et al. [22] studied both technical and value-change dynamics in livestock farming systems in three French mountain production areas. Their approach is based on moral and policy sociology [15] and the Actor network theory (ANT, [23]). The study of Fleury et al. [22] is close to the concept of worldview, however it is limited to understanding agricultural transformations more broadly. Indeed, the study focuses on a specific agro-environmental measure for biodiversity ("flowering meadows"). Blesh and Wolf [24] propose an integrated socioecological analysis of agroecological transitions (grain farmers and rotational graziers) in the Mississippi, but they do not refer to the concept of worldview. Boogaard et al. [25] show how the sociocultural sustainability of livestock farming systems is socially and culturally constructed by people in specific contexts, but they do not refer to the agroecological transition. Furthermore, Plumecocq et al. [26] have studied the plurality of values in six agriculture models in relation with agroecology. These authors use a moral and policy sociology framework [15]

and identify diverse lock-in and coevolution patterns. However, this study only considers limited aspects of worldviews and more research is needed to understand in greater detail this characterization of agricultural models [26]. Moreover, the evolutionary approach proposed by Rigolot [19] remains mostly theoretical.

The aim of the present paper is to characterize worldviews in livestock farming and associated dynamics in relation to the agroecological transition. A study was initiated in three French Protected Designation of Origin (PDO) cheese mountain areas. PDO areas are particularly relevant to the study of the agroecological transition. Indeed, they must differentiate from the dominant system and search alternatives to standardization and globalization, as the consumer is expecting typical and more “natural” products from PDO systems. To some extent, PDO systems can be regarded already as an alternative to dominant modern production, but not yet as fully agroecological. In the first part, we present the case studies and methods. To characterize how farmers “view the world”, our approach is first to identify which entities they typically consider or distinguish and the predominant types of relations they have with these entities (the “cosmology” in anthropology, [14]). In particular, Hedlund de Wit [17] has identified several dimensions for characterizing a worldview, notably ontological, epistemological and axiological (values) dimensions. To integrate these dimensions, we consider the ontological background, the sources of knowledge, and worlds of justifications [15] associated to the cosmologies. On this basis, four ideal-typical worldviews are characterized for a farmer population and related to specific management practices. Then, from three farmers’ monographs, we show that these ideal-typical worldviews coexist not only at the territorial but also at the individual scale. Finally, we discuss why this coexistence of worldviews should be considered as a key driver of the agroecological transition.

2. Case Studies and Methods

2.1. Case Studies

A research and development project was carried out from 2014 to 2017 with the aim of studying the links between the forage autonomy of mountain PDO dairy farms and nature. This work was undertaken in particular in the Central Massif and the Alps, focusing on three PDO cow cheese areas: Saint Nectaire (Central Massif), Tome des Bauges (Alps) and Beaufort (Alps) (Figure 1).

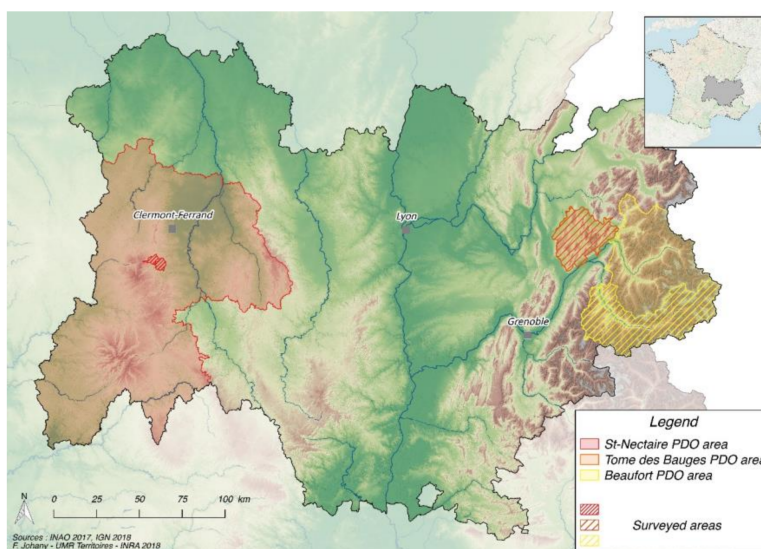


Figure 1. Localization of the three Protected Designation of Origin (PDO) areas (Saint Nectaire, Tome des Bauges, Beaufort) and surveyed areas.

In each of the three PDO areas, the PDO label defines specific farm-management practices, which are allowed or forbidden (Table 1). The three PDO labels aim at encouraging grass-based feeding, with a preference for local permanent grasslands. Cow supplementation is limited, as well as milk production per cow in Tome des Bauges and Beaufort. Local cow breeds are imposed and fermented forage are forbidden in Tome des Bauges and Beaufort.

Table 1. Some specifications of farm management for Tome des Bauges, Beaufort and Saint Nectaire PDO cheese.

	Tome des Bauges PDO	Beaufort PDO	St Nectaire PDO
Breed	Abondance and Tarine (at least 50% of the herd), Montbéliarde	Abondance, Tarine	No breed imposed. Cows and heifers born in the area
Maximum milk production per cow per year	6000 kg	5000 kg	No maximum
Maximum supplementation	1500 kg/cow/year	Summer: 1,5 kg/cow/day (summer mountain) or 2,5 kg/cow/day Winter: Maximum 1/3 of total feed amounts	1800 kg/cow/year
Minimum amount of forage from the PDO area	70%	75%	70%
Fermented fodder	Forbidden	Forbidden	Allowed for 15% of the total year ration
Minimum grazing period	minimum of 120 days/year	From snowmelt as long as bearing capacity and grass growth are possible	minimum of 160 day/year
Other feeding specifications	Maximum 500 kg dried alfalfa; Maximum other feedstuff 1800 kg/cow/year	Winter: Minimum 13 kg hau/cox/day; Maximum 3 kg dried alfalfa/cow/day	Maximum other feedstuff 1800 kg/cow/year

For this study, the whole Tome des Bauges area was considered and smaller areas were targeted within Beaufort (Maurienne) and Saint Nectaire areas (Figure 1). The dairy farmers contributed to the study on a voluntary basis (10 farmers in the Tome des Bauges area, 12 farmers in the Beaufort area (Maurienne) and 15 farmers on the Saint Nectaire area).

2.2. Methods

2.2.1. Quantitative Surveys

In each of the three case studies, all the voluntary farms were first studied by quantitative survey. For every farm, quantitative data on farm management and the fodder system were collected by means of two existing tools: DIALOG [27] to characterize grasslands management (grazing and mowing) and DIAM [28] to characterize the whole farming system (production and environmental indicators). These surveys were performed by the usual agricultural advisers following each farm. Particularly, these tools calculate a quantitative indicator on the percentage of diversified mown meadow. A mown meadow is considered as diversified when grass species represent less than 75% of the meadow and when there is no invasive dominant species (under 20% of the meadow).

In the Beaufort area (Table 2), the size of farms range from 56 ha to 203 ha. The maximum size of the cattle herd is 74 Livestock units (LU) and the average annual stocking rate is 0.5 LU/ha. The average milk production per cow is 3950 L for 1080 kg of supplement. In this area of high altitude (1446 m on average, Figure 1), the percentage of forage purchased can reach 57% within a farm. In the Tome des Bauges area, the altitude is lower (675 m) and farms are more autonomous for forage. The size of farm can be important (223 ha), as well as herd size: 100 LU on average. The annual stoking rate is also higher: 0.84 LU/ha. Dairy cows produce 5000 L of milk for 1288 kg of supplement. In the Saint Nectaire area (950 m height), farm size is close to the Tome des Bauges area: 111 ha on average. Herd size is higher (118 LU on average) and the annual stocking rate is 1.1 LU/ha. Dairy cows produce on average 6900 L of milk for 1620 kg of supplement.

Table 2. Farm characteristics in the three surveyed areas.

	Beaufort PDO			Tome des Bauges PDO			Saint Nectaire PDO		
	mean	min	max	mean	min	max	mean	min	max
Utilized agricultural area (ha)	125	56	203	130	51	223	111	65	195
Number of livestock unit on the farm (LU)	52	33	74	100	56	154	118	61	211
Altitude (m)	1446	1350	1550	675	550	900	958	800	1050
Milk production per cow per year (L)	3953	2369	5000	5037	4375	5818	6902	4000	9000
Quantity of concentrate per cow per year (kg)	1084	625	1260	1288	900	1800	1628	927	2710
Quantity of concentrate per liter milk year (kg)	270	174	411	259	189	411	242	168	392
Annual stocking rate (LU/ha)	0.5	0.26	0.77	0.84	0.52	1.41	1.1	0.8	1.5
% Forage bought	20	0	57	10	0	32	3	0	8
% Mown meadows diversified	32	0	100	8	0	16	43	4	85

2.2.2. Qualitative Surveys

In a second step, comprehensive interviews [29] were performed in the studied farms. Because of the duration of the interviews (about 2 h), only the available farmers (N = 27) during this second step were surveyed (6 farmers in the Beaufort area, 11 farmers in the Saint Nectaire area and all 10 farmers in the Tome des Bauges area). Comprehensive interviews used the method of the daily schedule and multiannual schedule to reach the farmers' vision on their forage system. The interview was conducted in such a way that "let come" key entities were considered and the relationships with them. Every interview was fully recorded and literally transcribed. From each interview, a deep analysis has been carried out with students to identify specific combinations of entities and associated worlds of justifications and ontological backgrounds. Then, ideal-typical worldviews have been characterized from the whole farmer population (pooling all interviews together). An ideal-type is defined as a construction of the researcher from potentially disparate phenomena, which are connected by abstract and simplified ideas, whose features are accentuated and contrasted [30]. Emerging ideal-typical worldviews have been associated to specific management practices (grazing and forage-making strategies, key indicators . . .) and stabilized through multiple exchanges and workshops between farmers, researchers and advisers. Quantitative indicators (milk production per cow per year (L) and mown meadows diversified) have been estimated by expert judgment, as an average of the most representative farms of each ideal-typical worldview in the three case studies. Finally, returning to individual interviews, we performed monographs to identify how different worldviews might coexist at the individual scale. In the Results section, we present the ideal-typical worldviews identified and three particularly relevant monographs, one in each case study area.

3. Results

3.1. Characterization of Four Ideal-Typical Worldviews

Four ideal-typical worldviews emerged from the analysis. Their names have been chosen to convey a general idea of their main characteristics, summarized in Table 3. **The Modern** management is characterized by a search for a maximization and control of pastures and animals' productions. For pasture management, the farmer is watchful about grass leaves, their density and their green color. These characteristics corresponding to young grass are essential for grazing and mowing management: "The right stage is when there are leaves, when it is dense and very green". Through a fast rotational grazing, the searched quality is high palatability for animals, which enables high milk production "We have to take the cows out early because milk increases immediately (. . .) young grass has a high palatability, which is what we are searching for, because animals who don't eat don't produce either . . . We have to look at the milk tank". Conversely, flowers and seeds are seen as signs of an excessively late stage, which should be avoided: "The right stage is not when there are flowers and ears Then it is too late: for sure if you want a good hay there must not be flowers in it". Animals are mainly seen and managed through the milk they produce (quantity, fat and protein content, germs), as well as biological characteristics related to milk production (such as the ability to walk in a fast-rotating system): "The genetic selection is mainly based on milk, production, the udder and teats and also those

who are easy to milk and with good aplomb, because here they have to walk". Technical equipment is adapted and efficient to act fast, as required by the vegetation stage targeted by the farmer and the specialization of pastures: "We have to do with the weather, but we are well equipped and as soon there is an opportunity, we can mow the paddocks". Natural resources are controlled through quantitative analysis of feed, forage and manure. These analyses are performed by experts who are trusted by the farmer and set the norms. Predominant words of justification are industrial and market. The PDO label is considered, firstly, as an economic benefit: "PDO represents an image and this is this image which makes a difference in milk price". However, the label is also seen as a constraint: "The evolution of the PDO, I grumble, but we have to do with it, there are products we could make (. . .) but it is forbidden (. . .) the label limit us for animal supplementation". Finally, the analysis of how entities are distinguished clearly show that human and non-human entities are separated (naturalist ontology).

Table 3. Description of the four ideal-typical worldviews characteristics, implications for pasture-management practices and some quantitative indicators (in italics) (see text for further explanations).

	Modern	Traditional	Ecological Intensive	Holist
Farming Principle	Maximization	Habits	Optimization	Care
Predominant Types of Relation with Entities	Production, control	Continuity with familial and local way of farming	Production efficiency	Production, protection, transmission
Entities Typically Considered or Distinguished	Homogeneous pastures	Domestic world clearly distinguished from natural world	Heterogeneous pastures	Huge diversity of closely connected farming and nature entities
Typical Indicators for Pasture Management	Density and green color of vegetation leaves	Dates, Moon cycle and calendar	Pasture and soil potential (acidity, clay content, rocks, bearing capacity . . .)	Pasture and soil potential Animal health, Flowers and seeds
Grazing Strategy	Fast rotational grazing (paddock)	Continuous grazing	Slow rotational grazing	Slow rotational grazing
Forage-Making Strategy	Early forage	Late forage	Early forage	Early and late forage
Source of Knowledge	Experts	Family	Experts and peers	PeersReflexivity
Worlds of Justification	Industrial, Market	Domestic, Renown	Renown, Civic	Renown, Civic
Ontology	Naturalist	Animist intuition	Naturalist	Analogue intuition
<i>Milk production per cow per year (L)</i>	<i>5619</i>	<i>5068</i>	<i>5532</i>	<i>5291</i>
<i>Mown meadows diversified (%)</i>	<i>14</i>	<i>36</i>	<i>14</i>	<i>49</i>

The **Ecological Intensive** is characterized by a logic of optimization (Table 3). Although he actively searches for good productivity for grasslands and animals, as the Modern does, the Ecological Intensive is also particularly sensitive to the heterogeneity and the specific potential of pastures. For him, "We have to live locally, we have to do with local resources". Pasture management typically integrates the soil characteristics (acidity, clay content, rocks . . .). Unlike the Modern, the Ecological Intensive does not aim to control his environment: "The farmer has to accept fluctuations . . . there are some farmers, they don't like this". Rather, animal and pasture production is associated with efficiency: "When we started farming we want to produce milk, we calculate as much milk makes as much [money] . . . but it is finished now, when we see those who produce 10,000 L (per cow) and who can't get a revenue". The Ecological Intensive is not against high-tech technical equipment, provided it is consistent with an efficient system: "I think we musn't be against the milking robot. The technic of milking with a robot is not stupid (. . .). The problem today with the milking robot is that cows don't go out in the field". The dominant source of knowledge for the farmer is related to exchanges in groups of peers who have already developed a slow rotational grazing strategy. Interviewed farmers have been to Jura, Switzerland and even to New-Zealand. Worlds of justifications are typically renowned and civic. The PDO label is essential for the identity of the Ecological Intensive, which has consequences for milk and animal management: "For the Tomme des Bauges you need to keep a natural (microorganism) flora. Otherwise you can all sanitize and then reseed but there is no more

natural flora”; “(The cows) need to have nice horns, a nice color . . . they are the image of our PDO”. As the Modern, the Ecological Intensive acknowledges the economic benefit provided by the label; however, in this case he is well aware of the contribution of his own farming practices to the image of the PDO.

As the Ecological Intensive, the **Holist** clearly perceive pastures as heterogeneous. Moreover, pastures are also seen as closely connected with animals, milk and nature entities: “The PDO it is a whole, it connects pastures with ecology with flower diversity, land preservation so everybody is fine with it”. Farming activity is seen as part of nature, whose protection and transmission are essential: “We shouldn’t want to do more than what nature wants to give us (. . .) we take some part of what nature wants to give us”. Seeds and flowers are essential for pastures’ sustainability: “There, seeds have fallen, we have sown the pasture for 20 years”; “if there is no more bees, it is said we are dead . . . I have noticed that since we have bees we have more clover than before (. . .) some farmers, they cut everything, but in a few years they will cry”. For forage making, he does not target mainly young green grass, which is associated to animal health issues. Rather, his aim is to diversify grass growth stages for hay making : “For hay making, we don’t hurry, we let mature, we change, we don’t always begin the same way . . . ”, “We don’t do like others who absolutely want to make three cuts (. . .) today we see a lot of farms making very very young hay (. . .) For my concern I prefer hay spread out in time for animal feeding”. In particular, “A good hay is when there are flowers and seeds inside . . . not too rich from a nutrition point of view, it is not with that that a lot of milk will be produced, but the animals like it more”. As for the Ecological Intensive, the Holist’s dominant worlds of justification are renown and civic. Moreover, as regards the PDO identity, he does not emphasize only the relation of his practices and the product’s image, but also the strong connections to nature, “When it is full of flowers, yellow, purple . . . for the taste of the cheese, it is not the same (. . .) They can say what they want (other farmers), grass grazed in our natural pasture, the perfume of the cheese is not the same”. Human and non-human entities are clearly seen as differentiated but closely connected, which can be considered as an animist intuition.

The **Traditional** clearly distinguish a domesticated world and a natural world: “Grass, it has always been there, we have just to preserve it, otherwise spikes invade everything, we are less and less (farmers) and we can see, the mountain is coming down”. For both grazing and forage-making management, production criteria are not the most important for decision-making, compared to what ones’ “father was doing” or to dates traditionally set up: “They tell us we must let the animals go out earlier, it is true I could do this, the grass would be less high (. . .) but I have always done it like that (. . .)”; “We always make hay at the end of June, we never start early, we trust the date”. As a consequence, grazing and cutting periods are particularly late and there are often already flowers and ears in the grass. Interestingly, for one of the farmers interviewed, grass palatability is not evaluated from the vegetation composition or growth stage, but from the period of manure spreading according to the Moon calendar: “If we don’t spread (the manure) during the good Moon, they (the cows) don’t want it, I don’t know, it must smell”. Moreover, to interact with his animals, the Traditional farmer takes their point of view: “We have to put ourselves in the position of the cows (. . .) the goats, they eat everything that they are unwilling to eat and the more they compare themselves to the cow, the more they are happy”. Non-human entities, particularly animals, are given typically human characteristics, which can be interpreted as an animist intuition.

Quantitative indicators must be considered with care for illustrative purposes only, because their estimations rely on crude methodological simplifications. Despite these limits, it is interesting to note that milk production per cow tends to be higher for the Modern and Ecological Intensive, whereas mown meadow diversity tends to be higher for the Holist and Traditional worldviews.

3.2. Coexistence of Worldviews in Individual Farmers (Monographs)

3.2.1. Ecological Intensive Practices but Holist Desires (Saint Nectaire Area)

This farmer has started farming activity in the Saint Nectaire PDO area three years ago. He has 80 dairy cows and 110 ha pastures, mostly natural. Farm management typically corresponds to the Ecological Intensive ideal-type. Indeed, the foraging system is associated with a slow rotational grazing system, taking into account pasture heterogeneity and aiming at an early forage. Herd management is associated with high milk production objectives: "It would be good to have a fat content of 40 g/kg and a correlated protein content at 32 g/kg". However, when talking about his system, he is very critical about his own practices: "I have the impression I have an impoverishment of my flora (. . .) I have the impression I have mutilated most of my pastures, because I cut them too early; therefore they don't have time to reproduce themselves (. . .) instead of hogweed, if only I had a nice red clover, I think it would be better". Moreover, he worries about the consequences of early forage on animal health: "There is not enough fiber, me, I forgot this in my system (. . .) I am fed up managing the pathologies of my animals (. . .) I want to become an animal farmer again!". For this farmer, a good way of farming is different from what he does himself. He takes as a reference a neighbor, considered by his peers as a marginal: "There it is, when I come by his field, the pasture is beautiful and it smells nice, it's a hay like this I would like to make . . . "; however, he goes on by expressing his lack of practical experience " . . . but how does he do it?". This Holist desire is a driver of change. Indeed, the farmer has engaged himself in a peer group of practical exchanges in an association called "Eleveur autrement" ("livestock farmer another way") and he is currently testing "alternative methods".

3.2.2. Ecological Intensive for Grazing Management and Holist for Hay Making (Les Bauges Area)

The farm has 200 ha and 154 livestock units. The farmer considers his pastures as heterogeneous: "There are different altitudes, some fields are more or less sunny, others are more humid . . . therefore the fields don't start the same time". Grazing management is rotational and relatively fast, "we turn after 30 days, it is rotational grazing and we move the string every day, in the morning and the evening". This management aims for young grass and good animal productivity: "the more it is short (the grass), the more they like it, for milk production, it is better". However, when talking about hay, the farmer does not use the same attributes anymore: "here is a good little mountain hay (. . .) not too rich from a nutrition point of view, it is not with that that a lot of milk will be produced, but the animals like it more". Moreover, then he highlights the typically Holist notions of transmission and protection: "we shouldn't want to do more than what nature wants to give us (. . .) we take some part of what nature wants to give us . . . us, we have remained 'nature'". The coexistence of Ecological Intensive worldview for grazing and Holist worldview for hay making leads to seemingly discordant statements: "grass grazed in our natural pasture, the perfume of the cheese is not the same" and later "they must produce milk, they must be easy to milk and operational".

3.2.3. From Traditional to Modern: Temporal Coexistence (Beaufort Area)

This farmer started farming activity in 2009 with his parents and then with his sister. They have about 60 livestock units and 117 ha. When talking about his practices, the farmer often refers to the familial traditions: "It has always been like this (. . .) We have always done like this, it is the practical way". However, for three years the farmer has been willing to produce a younger hay and make the animals graze earlier in order to increase milk production (as a Modern typically does): "It was our will to come around faster, every three weeks roughly". Yet, the rationale for earlier grazing still integrates judgements taken from the cows' point of view: "Before there was too much grass, they didn't eat well, it was fields they didn't enjoy to go in, they couldn't see anything". The farmer expresses the technical difficulties raised by the transition: "We are too slow at the beginning, every time we are fooled, we turn at 35–40 days and then when we come back for the second time, the milk, it decreases,

it is obvious, because the grass is too old”; “Every year we are fooled and this year again we have been fooled”.

4. Discussion

4.1. Consistency and Significance of the Results

Defining ideal-typical worldviews requires an emphasis upon characteristic attributes from a population of farmers. No individual farmer can be said to be Modern or Holist as a whole, although individuals generally have a dominant worldview. The three monographs clearly demonstrate this complexity at the individual scale. However, four contrasted ideal-typical worldviews clearly emerged. The entities and relations considered are very different, as well as knowledge sources, worlds of justification and ontology. These contrasted backgrounds are associated with different grazing and forage-making strategies, each with very specific indicators. The four worldviews identified have interesting similarities and differences with other typologies in literature. In particular, Plumecocq et al. [26] identify six types of agricultural models with different underlying values and different forms of organization. Some types are close to those identified in this paper (for example, the “historical-conventional model based on an industrial/market compromise” with the Modern). Other types correspond to very different agricultural systems compared to livestock farming systems in PDO areas, so there is no obvious correspondence (for example, the “biotech model”). Nevertheless, the biggest difference between both typologies lies in how they have been elaborated. Indeed, the typology of Plumecocq et al. [26] has been elaborated in a series of workshops with specialists in natural and social sciences. By contrast, the typology proposed in this paper is directly based on what farmers say about their own actions and the meaning they give to them. The four ideal-typical worldviews of this paper are also consistent with the four major types broadly identified in literature (Traditional; Modern; Postmodern; Integral) [17,18,31] and specified for agriculture by Rigolot [19]. In particular, the Traditional and Modern worldviews of our study very well match with worldviews of the same name in literature (for example, the Traditional type is associated with an ontological animist intuition and a domestic world of justification, the Modern type with a naturalist ontology and industrial and market worlds of justification). The Ecological Intensive is closer to the Postmodern type of this literature, but does not fully correspond. Indeed, although critical about modernity, the Ecological Intensive still shares important characteristics with the Modern (particularly, a naturalist ontology). The Holist also shares many characteristics with the Integral type in literature (deep connection with nature . . .), but not all (such as the major focus on spirituality and consciousness) of the Integral [32]. Rather, Ecological Intensive and Holist correspond to intermediary types, such as proposed by Beck and Cowan [33] in their “spiral dynamics”.

4.2. Worldviews and Agroecology

As illustrated by the “Mown meadows diversified” quantitative indicator, all the four worldviews can contribute to biodiversity. Yet only the Ecological Intensive and Holist worldviews can be considered somehow as “agroecological”, because only these two explicitly integrate ecological processes, to some extent. In particular, both worldviews acknowledge the heterogeneity and specific potential of living entities, which is essential for integrating ecological processes. Notably, we choose the phrasing Ecological Intensive in reference to the concept “ecological intensification”, defined by [34] as “the use of biological regulation in agroecosystems to achieve both a high level of food production and provide ecosystem services”. However, these two worldviews also correspond to two very different conceptions of agroecology, rather conformist and transformational, which is also consistent with literature [35]. Particularly, only the Holist worldview proposes a deep renewal of the meaning of man existing together with nature [14]. This new meaning is not only based on a relation of production (dominant in the Ecological Intensive), but on a complex relationship between the farmer and nature, involving production, transmission and protection from humans and a gift

from nature [36]. The overall sustainability of a livestock farming system is beyond the scope of this paper, but other aspects such as animal welfare, are also closely related to worldviews.

Contrary to more theoretical worldview studies (such as [19]), the results proposed in this paper are based on real field data from comprehensive interviews with farmers. Moreover, each worldview has been associated with specific knowledge sources and technical management practices, such as continuous and slow or fast rotational grazing. This has important practical implications for farm-advising systems. The current French advisory system has been typically associated and adapted to Modern agricultural development since World War II. Since the 1980s, however, both the advisory and education systems have increasingly integrated the environment, pluridisciplinarity and systemic approaches [37], corresponding rather more to an Ecological Intensive development model. From the farmer's point of view, experts such as technical advisers are still an important source of knowledge in the Ecological Intensive worldview and a secondary source of knowledge in the Holist's worldview. Therefore, experts have a substantial role to play in the agroecological transition. For them, different worldviews imply different success indicators and different pathways. Our results give useful insights for technical experts to adapt their advice to each farmer. A proposal of this work is to communicate ideas on worldviews to experts with simple information sheets. At a larger level, the development of agroecological worldviews (Ecological Intensive and Holist) imply more distributed knowledge management systems, where farmers themselves would play a much more active role [38]. In the education system, Cayre [39] show that strongly involving students together with other actors constitutes relevant distributed knowledge management when it comes to enhancing reflexivity about values and worldviews.

4.3. The Coexistence of Multiple Worldviews is a Key Driver of the Agroecological Transition

Each of the four ideal-typical worldviews has been identified in the three studied PDO areas (Tome des Bauges, Saint Nectaire and Beaufort). Because we did not perform quantitative analysis, exact proportions are not known. However, it appears clear that the dominant worldviews in the three areas are the Ecological Intensive and, to a lesser extent, the Modern, whereas Traditional and Holist worldviews are far less widespread. This is consistent with an understanding of PDO as an alternative to dominant system, but not yet fully agroecological. To further strengthen our approach, quantitative approaches could be used [40] to assess the respective weight of each ideal-typical worldview and their geographical repartition.

At the individual scale, the three monographs clearly show that different worldviews also coexist: a farmer can be Ecological Intensive in practice but Holist in desires, Ecological Intensive for grazing management and Holist for hay-making, or have a Modern tendency with a remaining Traditional way of doing. In the first case, the gap between practices and desires is a source of suffering for the farmer, which drives the experimentation of "alternative practices". Because a Holist worldview also coexists at the scale of the PDO area, this farmer can rely on a peer group of practical exchanges. The two other monographs show that transitions are complex and do not transform the system as a whole in the same time. The farmer in the Beaufort area can be seen as starting a transition to modernity, but the monograph show how it is difficult technically, because of remaining habits. The situation of the farmer in Les Bauges can be seen as a more advanced stage of transition, leading to seemingly discordant practices. As most typologies of agricultural systems often do not explicitly recognize this complexity at the farm scale, we believe this is a particularly important insight of this study.

The key role of the coexistence of multiple worldviews to foster sustainable transformations has already been developed in literature [41]. This role can be enhanced by facilitating the confrontation of worldviews and exchanges between them. Interestingly, the present study has clearly contributed in revealing the plurality of values to the actors, particularly during collective workshops. For example, the farmer in the Saint Nectaire area with Holist desires (first monograph) has been confronted in a workshop by a map produced by researchers showing the intensification of his practices, which has generated reflexivity. Importantly, however, the confrontation of worldviews requires methodological

precautions and innovations, notably for the inclusion of non-human entities and the definition of what matters [42]. Research can play an important role in the agroecological transition, not by defining the “one best way”, but particularly in its contribution to the process of worldview confrontation.

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