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Exploratory study of the behavior of horses performing weed control in vineyards: Caract-Equivigne project

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Exploratory study of the behavior of horses performing weed control in vineyards: Caract-Equivigne project

Etude exploratoire du comportement des chevaux de trait utilisés pour le contrôle des adventices dans les vignes : Projet Caract-Equivigne

Key-words: Draught horse, discomfort, behavior, ethologie, vineyard, agroecology

Mots clés : Cheval de trait, inconfort, comportement, ethologie, vignes, agroecologie

Résumé:

Dans ce mémoire, nous avons élaboré un ethogramme du cheval de trait décavaillonant la vigne, en observant des enregistrement vidéo de ces chevaux au travail. L'ethogramme est étayé de description détaillée, et lorsque ça a été possible, d'illustration. Nous avons également effectué une recherche bibliographique afin de trouver des articles mentionnant des comportements potentiellement marqueur d'un inconfort du cheval. Nous avons ensuite trié ces comportements en choisissant ceux adapté à l'activité pratiquée par les chevaux que nous avons observés, et en retenant ceux observables au vu de la qualité et des conditions de prise de vidéo. Nous avons également essayé d'enrichir et de clarifier les définitions des comportements sélectionnés dans la littérature, et lorsque c'était possible, nous les avons illustrés. Néanmoins, puis la suite du projet Caract-Equivigne, il sera nécessaire de finir d'illustrer tous les comportements pertinents et d'enrichir ces ethogrammes. Au cours de l'élaboration de ces ethogrammes, des défis méthodologiques et techniques ont été rencontrés. Nous avons essayé d'apporter quelques clefs à ces éléments pour les prochaines années du projet, néanmoins, malgré ces premières pistes, il est tout de même nécessaire pour l'année prochaine de continuer à tester l'utilisation de ces ethogrames et les méthodes développées dans ce mémoire. En particulier, il faudra faire appel à un autre observateur pour confirmer les variabilités inter et intra observateur. Enfin, pour l'année prochaine, nous avons aussi soulevé la possibilité de relever tous les comportements du cheval (incluant les comportements d'inconfort), afin d'essayer d'identifier les comportements apparaissant ensemble dans les vidéos.

Abstract:

In this master's thesis, we have elaborated an ethogram of draught horses plowing down ridges in the vineyard by observing videos of these horsing working, and by providing the most precise definitions and illustrations possible. We have then searched through the literature to find an article mentioning behaviors potentially linked to discomfort, we have sorted out these behaviors, choosing those adapted to the activity performed by the horses we observed, and separated those that were observable on our

videos. We also tried to enrich and clarify the existing definitions in the literature, and if possible, to image them. Nevertheless, for the continuation of the Caract-Equivigne project, it will be to finish illustrating the behaviors which could not be illustrated in this report and to continue to enrich these ethograms. During the elaboration of these ethograms, some technical and methodological challenges have been encountered, and we have tried to bring some keys to face them next year. Despite these first tracks, it is also necessary next year to continue to test the method, in particular by calling upon another observer, to confirm the inter and intra observer variability. Finally, we raised the possibility of recording all the horse's behaviors (including discomfort), to try to identify the behaviors appearing in number on the same videos.

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Introduction

1. A bit of history: horses as a source of power

Figure 1. A man plowing a field with his horses in the 1940's. ©The Agassiz-Harrison Historical Society

Early in the long-lasting relationship between horses and humans, the latter learned to rely on the horse not only as a food source but also as a means of transport and a source of power for agricultural and other work practices (Górecka-Bruzda et al., 2015, p. 1). For a long time, agriculture in France was maintained through small family properties, which relied on horse traction, particularly for specialised crops, vines and market gardening (Fig 1).

However, from the inter-war period onwards, the modernization of agriculture and the massive introduction of tractors relagated this traditional traction activity to an anecdotal level. The number of draught horses in France has not stopped decreasing since that time (Lizet et al., 2015).

Since the 2000s, however, there has been a new dynamic in equine traction use for various agricultural needs, such as mechanical weeding of vineyard soils. These professionals are driven by various convictions: caring for the soil, reducing the use of fossil fuels, considering the impact of their practices on agroecosystem health or else conserving draught horse breeds (ifce et al., 2020; Lizet et al., 2015).

2. Equine traction as a support for agroecology in vineyards

Several arguments have been put forward to support the use of equine traction as an agroecological practice. If we look in particular at those linked to the use of horsepower for working the soil in vineyards, this includes the limitation of chemical input use, notably herbicides, by using instead a mechanical weeding performed by the horse. This leads to the wine potentially having environmental labels. Winegrowers can also organize tourist events on the vineyards with the horse. Altogether, the environmental labels and opporunity for tourist events can favour the wine promotion (ifce et al., 2020).

Far from replacing the mechanisation of agricultural operations, equine traction can be used in complement to tractors on vineyards. For instance, it allows for high-precision work (ifce et al., 2020), making it possible to monitor individual vines and maintain old, more delicate plots of land, or plots that

Figure 2. Weed control in vineyards using horses: the worker in direct contact with the agroecosystem. ©Studio-vaison

are inaccessible or inoperable with motorised equipment (such as plots of land located on steep or terraced hillsides).

Horses have an emotional intelligence (ifce et al., 2020) which differentiate them from simple work tools. The operator walks directly on the vineyard surface and must pay close attention to both the horse and the vines, while the tool he handles cuts the grass under the vine stocks (Fig 2). Through this close contact with his environment, he may develop capacities for attention, observation and understanding, giving him additional insight on the state of his agroecosystem (ifce et al., 2020). It can also impact larger scales of the agroeocosystem. For instance, the presence of the horse can influence social and professional relations on the farm, such as between the employees (ifce et al., 2020). It can also influence the relashionship betweeen the farm staff and its neighbours (farmers as well as other professions) (ifce et al., 2020).

The development of this practice nonetheless faces several challenges, such as the geographical splintering of professionals in the equine traction field, as well as the lack of training, making it difficult to transmit knowledge maintained by only a few individuals (ifce et al., 2020).

3. The Caract-Equivigne research project

In light of this context, the French Horse and Riding Institute (Ifce) and the French Institute of Vine and Wine (IFV), launched **the Caract-Equivigne project** at the beginning of 2022. It consists in the **characterisation of technical itineraries associated with equine traction within vineyard soil maintenance.** The goal of the project is to complete and enrich existing tools of reference as well as those under construction, on viticultural (soil, vine) and equine (horse and horse driver) data. Caract-Equivigne project focused on two main operations at the foot of the vines: **hilling** and

Figure 3. a) Hilling. ©Benoit Pasquier/ifce. b) . Plowing the ridges ©Léa Crombez/ifce

plowing the ridges (‘**décavaillonage’ in French)**. Usually operated during fall time, **hilling** consists of making a mound on earth around the vine stock, so that the grass is covered and limited in its growth (Domaine Montirius, 2018) (Fig 3a). At the end of the winter or later in the spring, the **plowing of the ridges** in performed. It consists in removing the mound of earth created during the hilling as close as possible to the vine stocks (Fig 3b). Both operations are performed once on each side on the vine rows.

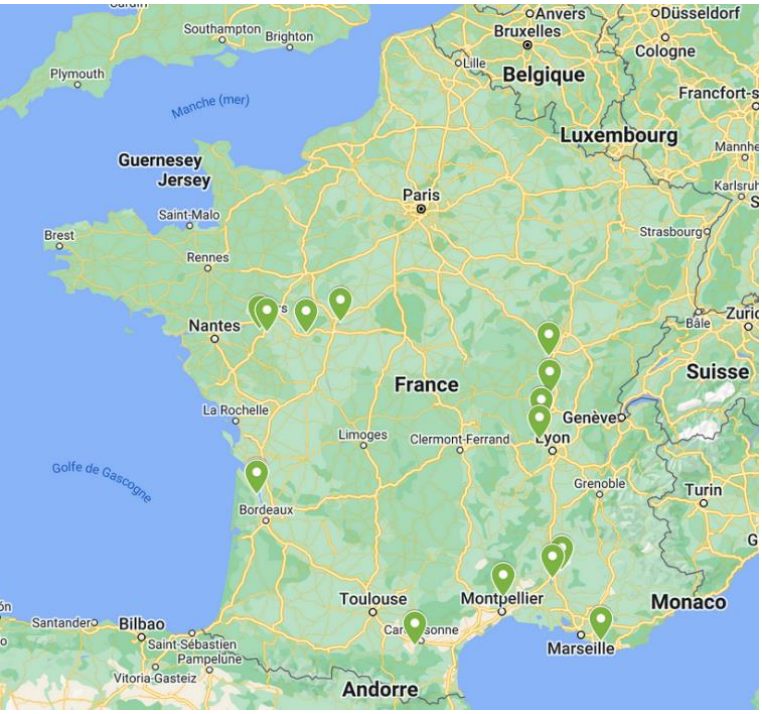

Figure 4. Distribution of the partner wine estates of the Caract-Equivigne project. ©Google maps, ifce and IFV.

Fifteen vineyards using equine traction, spread throughout metropolitan French wine-growing areas participated in this project (Fig 4). For two to three years, various measurements carried out each year during hilling and plowing of the ridgess. The measurements were on, among other factors, soil humidity, percentage of grass cover, the heart rate of the driver and horse while working, etc.

The end goal is to highlight and share the most efficient work itineraries possible using technical, economic and environmental terms, so that professionals have references at their disposal that take into account the agroecosystem as a whole. It should then make it easier for them to adapt this practice for their own production system.

Using the power of draught horses also means taking their welfare into consideration. Ensuring horse welfare is not only expected by consumers and the general public, but is also related to achieving appropriate levels of performance and profitability in the production system (AWIN, 2015, p. 9). Considering the welfare of the horse is thus a necessary condition to guarantee the efficiency and sustainability of this practice. In this regard, the Caract-Equivigne project also has the ambition to lay the foundation for a better understanding of the welfare of horses working in the vines.

4. Understanding horse welfare

Researchers have been working on the issue of animal welfare since the 1980s, seeking to define the concept and develop methods to assess it. Cornerstone research with regards to animal welfare is the European **Welfare Quality®** project (Briant et al., 2017). From 2004 to 2009, it developed a scheme where the needs of animals were related to four principles and twelve criteria considered necessary to cover all aspects of animal welfare (Fig 5).

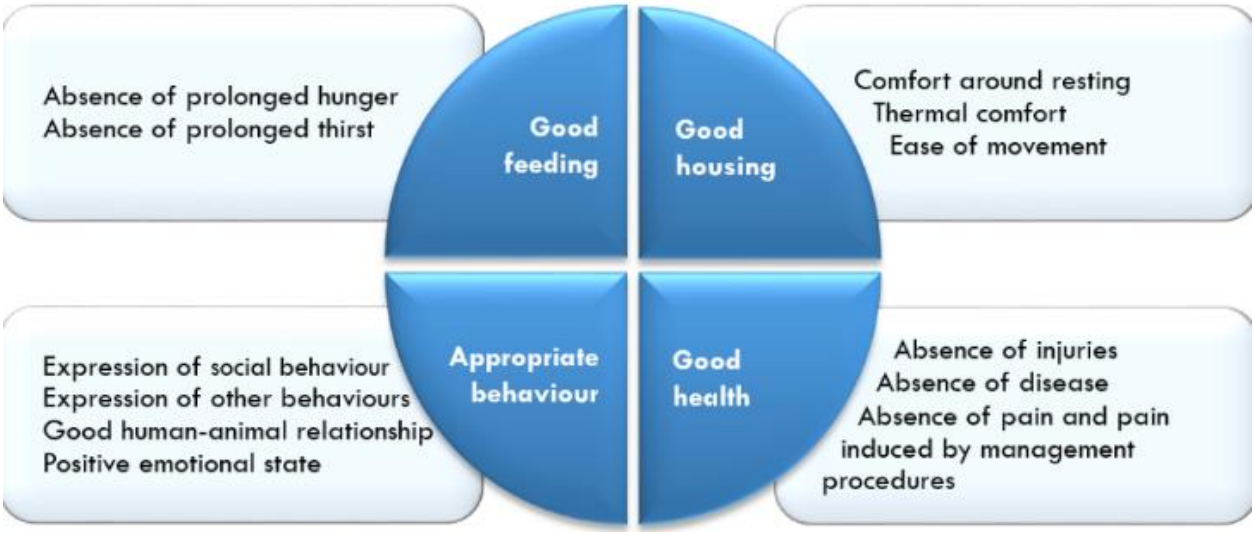

Figure 5. The 4 principles and 12 criteria of animal welfare, according to the Welfare Quality® Project, as presented by AWIN (2015).

This approach formed the basis for future research on welfare assessment at the farm level (AWIN, 2015, p. 9).

Based on the evolution of scientific knowledge in recent years, the French National Agency for Food, Environmental and Work Health Safety (ANSES) suggested in 2018 to define an animal's welfare as "the **positive mental and physical state** associated with the satisfaction of its **physiological and behavioral needs** and expectations. **This state varies** according to the **animal's perception of the situation"** (ANSES, 2018, p. 16). **A horse's general welfare will thus be partly a result of the accumulation of experiences it has had**. The more frequent are the situations it perceives positively, the better its general state of welfare is likely to be. Conversely, the more the scale is weighed down by negative experiences, the worse its general state of welfare is likely to be.

For some horses, **a large part of their experiences** is related to humans, whether it be around their rest time (for example during food distribution or veterinary care) or **in work situations** (for instance during ridden work or agricultural work). It is therefore necessary to look at how the horse perceives these working situations.

5. Study of horse behavior: a gateway to its perception of the work situation

Observing the horse is one way to find out about how it is feeling, since **an animal's behaviour is an expression of its relationship with its world** (Hausberger and Richard, 1999). Indeed, behaviour is a response to a given situation, through the combination severals elements, such as its environment, its previous experiences, or its physiology (Briant et al., 2017).

The science that studies the behavior of animal species is called ethology. There are three main steps in this science that allow one to better qualify and understand the behaviors observed in an animal (Hausberger and Richard, 1999). The first step consists of making **open observations** of the behaviors without the constraint of a hypothesis. Following these observations, the ethologist will construct an **ethogram**, i.e., a **repertoire of all possible behaviors** of the species or individual in a given context, each with strict definitions (qualitative approach). The construction of this ethogram allows the access to the last step: the **quantification of the behaviors**. This is done using standardized methods that allow us to determine the proportion of behaviors that occur and under which circumstances.

To date, **no study has investigated the behaviour of horses during agricultural work**, let alone during soil weeding in the vineyard. The researchers have mainly focused on the in box and ridden horse's behavioural repertoire reflecting negative emotional states. Two major approaches can be distinguished in these studies. One approach, notably initiated by veterinarians, focuses on the identification of **pain marker behaviours** in the horse, in particular pain related to underlying pathological conditions. The other approach concentrates on the rider/horse relationship, with an emphasis on identifying and quantifying so-called **"conflict" behaviours**. For example, head shaking behaviour as illustrated on the photograph on the right (Fig 6), can indicate that the horse is experiencing some kind of confusion, discomfort, resistance or hyperactivity to the rider's actions.

Figure 6. A horse shaking its head while ridden. ©S.Dyson

Such pain and conflict related behaviours can be grouped under the label of '**discomfort behaviours**'. Namely, behaviours triggered by any negative experience, regardless of how negative the experience is. Consequently, this definition encompasses any behaviour related to any level of pain, confusion, overstimulation, fear, anxiety, or frustration.

6. Working in the vineyard, a learning process for the horses…

Figure 7. Working on a delicate plot: on the edge of a precipice. ©Ifce

The mechanical weeding on the vineyards is a situation where horses have to deal with several potentially challenging elements. This is not an inborn activity for horses. Before they are ready to work regularly, they must get used to harnessing, to being led by a human, to pulling an object behind him, to responding in a certain way to stimuli, to adapting to various and sometimes stressful environments, as pictured in the Figure 7 on the left.

… which brings with it its share of challenges

If we take a look at a horse working between the vine stocks, we quickly realise that at a plot scale, working in this agricultural ecosystem presents potential challenges for the horse even after it has passed its initial learning phase: Is the harness adapted to its morphology and adjusted correctly? Is the plow being pulled not too heavy? Are the orders given by the horse driver clear and given at the right time? Is the ground in the field uneven or stony, making movement difficult? Is the slope not too steep? Are the weather conditions bearable?

These important considerations lead to wonder whether the horse feels discomfort during labour. The Carcat'Equivigne project thus plan on answering the following question: **How many discomfort behaviours are expressed by a draught horse performing weed control operations?**

7. Shift of focus: from ontology to methodology

On the way to deal with this question, we discovered other knowledge gaps that needed to be addressed before being able to quantify the horse's discomfort behaviours.

As highlighted earlier, studies conducted so far have focused on the ridden horse. Thus, it was not known whether the discomfort behaviours mentioned would be adapted to the case of vineyard work, or whether other behaviours specific to our study context would be expressed by the horses. In fact, before monitoring these signs of discomfort**, it is necessary to describe the whole behavioural repertoire that the horses we observe may show.** In the case of the Caract-Equivigne project, an ethogram of the draught horse working on vineyard weed control was necessary. **It was also necessary to test whether both the**

behaviors mentioned, and the methodology presented in the literature would be adapted to equine viticultural work and to our research protocol.

We were also challenged by the difficulty of interpreting behaviors descriptions listed in various rubrics of the publications. The sole, brief definition of a behaviour makes it quite hard to recognize it properly. As pointed out by Torcivia and McDonnell (2021), this is a common issue when using these discomfort ethograms which need to unambiguously describe behaviors. That is to say, naming and precisely defining each behaviour. When possible, some sort of illustration (such as a line drawing, photograph or video clip) should complete the description, leaving little room for error. It was therefore necessary to **construct photographic references - where possible - and to try to specify the definitions of discomfort behaviours taken from literature.**

In light of the existing research and of these considerations, the focus of this master thesis shifted to become the following:

Draught horses performing weed control operations in vineyards: Developpement of a general ethogram and an ethogram to record of potential discomfort behavior of the horse.

Firstly, we will explain in section 2 the materials and method elected, then in section 3, we will present our results. Finally, in the last section, we will discuss our results and their implication for the following years of the Caract-Equivigne project.

Methodology

1. Data construction

As mentioned in the introduction, the Caract-Equivigne project partnered with fifteen vineyards that use draught horses to weed mechanically under the rows of their vines. To be included in the Caract-Equivigne project, they had to have at least 2 plots weeded with the help of a horse and its driver. The criteria for choosing the vineyards, the driver-horse couples, and the plots studied are detailed in Appendix 1. The driver-horse pairs were then observed during their work twice a year for each plot: once for the hilling and once for the ridges plowing. Due to time constraints, this master's thesis focused on the latter.
Several measurements were carried out during these operations, in particular, videos of the horses during their work were recorded, to be observed later.

1.1. Video recording protocol : Day of the ridges plowing

We will present here only the part of the Caract-Equivigne protocol related to the video recording. The measurements were scheduled at the very beginning of the day to observe all horses at the same moment of the workday.

1- The protocol was reminded to the horse driver. Then, he/she signed the consent form (consent to the measurements being made, and to the measuring equipment being installed on his/her horse).
2- The drivee harnessed his/her horse, and the devices were fit on the horse (such as the dynamometer to measure the traction data).
3- The horse and the driver warmed up by plowing down ridges of a few vine rows.
4- Once the warm-up was over, digital action cameras (GoPro Hero5 camera, GoPro, U.S.A.) were set up on 2 technicians (Fig 8a.).
5- All the devices were then switched on and the driver and his/her horse started to work. Video recordings were made, one technician equipped with a camera walking at the horse's head and the other at its tail (Fig 8b), always placed on its left. The cameramen followed the horse during all the work in the row, but not during the half-turns to change row side.

6- After 20 minutes of recording, the measurements were stopped, and the devices switched off.

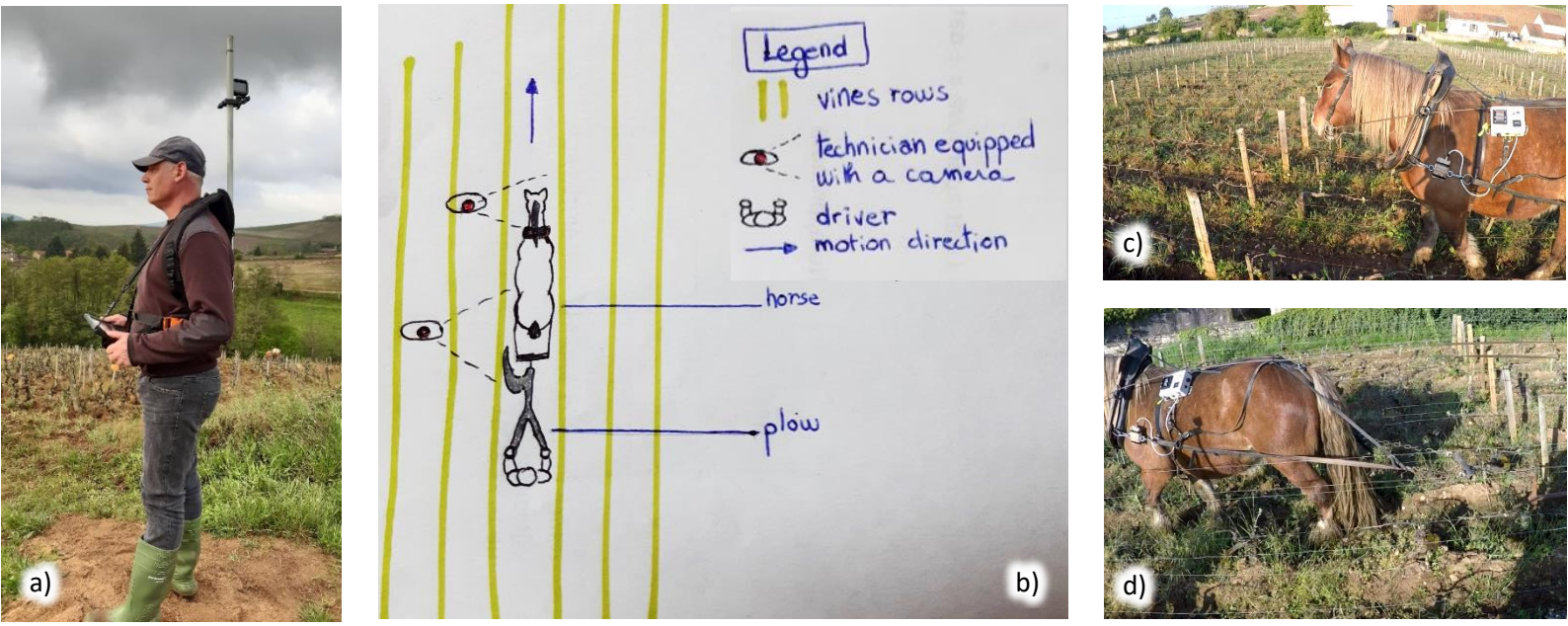

Figure 8. a) Set up of the camera attached to the technician with a harness. A pad displaying the camera helps to ensure proper framing. b) Aerial view of the placement of the cameras in comparison with the horse. ©Léa Crombez/ifce. c) View from the Head-Neck camera. d) View from the Tail camera.

7- At the end of each measurement sessions, 2 video recordings were obtained: one framed on the head and neck of the horse, the other on the tail (Fig 8c and 8d). These recording then served as a basis to developp an ethogram of all the behaviors expressed by a horse working in a vineyard.

1.2. Selection and description of the sample analysed

Since the first aim was here to define an ethogram of all the behaviors expressed by a horse working on a vineyard, it was chosen to favor the recordings of ridges plowing of contrasting physical intensity. The intensity of the physical exercise required by the horse was assimilated here to the force it had to produce to pull the plow. For the purpose of this master's thesis, **six horses were observed, with 2 videos per horse (1 « head » recording and 1 « tail » recording during the plowing of ridges for each horse)**. Two horses were observed in the highest traction thresholds of all operations measured in the Caract-Equivigne project, two others were in the lowest traction thresholds, and the last one was in the middle of the batch.

The subjects consisted of 4 geldings and 2 mares, and they were all Comtois breed. The age of the horses ranged from 7 to 16 years. They were all experienced with plowing the ridges (from 3 to 10 years of experience).

2. Observation of videos to build general ethogram of the draft horse plowing down vines' ridges

5 to 10 min of each of the 6 videos were then analysed with the Boris software **Boris** (v. 7.13.8) (Friard and Gamba, 2016). The videos were watched 2 to 3 times.

After consulting the bibliography, it appeared that the general term "behavior" actually includes several aspects: Dalla Costa and her colleagues (2014) divide for exemple the behaviours mentioned in their study as such: a category "general behaviors" and a category "postures". The general behaviors refer rather to movements of the body as a whole (e.g., walking, trotting, shaking the head), while the postures are observable when the video is paused (e.g., head held high). Facial expressions are all postures and movements concerning the horse's face in particular (e.g., dilated nostrils).

Therefore, the aim of the observation of the video was to list and describe all visible behaviors, facial expressions, and postures. Screenshoot of the behaviors were also made to construct references illustrations.

3. Construction of the ethogram to assess discomfort behaviors

Following the development of the general ethogram, a list of potential discomfort behaviors was constructed from the discomfort ethograms found in the literature.

As no study encompasses horses working in vineyards, the bibliographic research was conducted on ridden ethograms (dressage and show jumping). Ethograms of pain and conflict behavior were found. All the studies describing conflict behaviors had been made on ridden horses, while only one of the pain behaviors had been made on ridden horses. In order to emcompass more behaviors describing pain, the choice was made to also include ethograms describing horses in pain in their box. This meant that a selection of behaviors adapted to the horse at work was necessary. For instance, the behavior of directing the head toward a corner of the box (Dalla Costa et al., 2014) was not retained. For the ridden ethogram, the behaviors not adapted to the plowing the ridges practice were excluded. For instance, Dyson and her colleagues (2018a) mentioned the frequency of trot steps <40/15s, but the horse are not seen trotting, as the plowing down ridges requires the horses to walk slowly. The ethograms retained to construct the ethogram to evaluate horse discomfort behaviors are detailed hereunder:

3.1 Pain ethograms

- An equine pain face (Gleerup et al., 2015). (in box)
- Horse Grimace Face (HGS) (ref) (in box)
- Equine Utrecht University Scale for Composite Pain Assessment (EQUUS-COMPASS) (van Loon and Dierendonck, 2015) (in box)

- Equine Utrecht University Scale for Facial Assessment of Pain (EQUUS-FAP) (van Loon and Dierendonck, 2015) (in box)
- Horse Chronic Pain Scale (HCPS) (van Loon and Macri, 2021) (in box)
- Ridden Horse Pain Ethogram (RHpE) (Dyson et al., 2018a) (ridden, dressage)

3.2.Conflict ethograms

- Rider effects on horses'conflict behavior, rein tension, physiological measures and rideability scores (Christensen et al., 2021, 2014) (ridden, dressage)
- Conflict behavior in elite show jumping and dressage horses (Górecka-Bruzda et al., 2015) (ridden, dressage and show jupping)

This list was then confronted with the general ethogram and with the videos to select a list of potential discomfort behavior that could be later used to quantify the appearance of signs of discomfort in the horse during plowing down the ridges, construct references for each behavior and define the subcategories a of these behaviors (for instance, the eye position can be divided as 'closed' or 'open'). Photographic references were acquired by scanning every 10s of 5min from the beginning of each video.

In ethology, there are several ways to quantify the occurrence of a behavior, such as: percentage of time spent performing a behavior (time budget, e.g., time-budget spent walking), the percentage of scans where the behavior is expressed (one scan=pause on a frame of the video, repeated every x seconds) and occurrence of expressed behaviors (number of times on the video where the behavior is visible) (Briant et al., 2017). Time-budget is usually preferred for behavior performed for longer periods, whereas occurrence is suited for brief apparitions (Briant et al., 2017). As time-budget, scanning is preferred for lengthier behaviors, but can work with very frequent and brief behaviors. The construction of the ethogram of potential discomfort behaviors to be surveyed therefore also included suggestions of methodology to survey these behaviors.

Results obtained

1. General ethogram

1.1. Behaviors list

Table 1. General ethogram of horses plowing down ridges in vineyards

Behavior category	Name	Description
Facial expressions	**Ear mouvement & position**	The ears can often change position or be kept several second to minutes in the same position. The position range of each ear goes from a very forward position (with pinna facing foward), to a very backward position (pinna facing backward) passing through all the intermediate positions. The two ears can move together but also independently of each other, combining each of these positions. Positions can be monitored for exemple with these modifiers: **Forward** (both ears pinna facing forward completely or partially), **intermediate** (left ear pinna fully visible and right ear pinna symmetric or ears combining 2 positions), **backward (both ears pinna facing fully or partially backward.**
	Eye position	The eye position ranges from **open to slightly closed**. The eye blinks regularly.
	Sclera visible	Sclera (white of the eye) is **present**, showing quickly, or **absent**.
	Nostril position	Nostrils can be relaxed (teardrop shape), slightly tense (oval shape) or visibly dilated (round), and the intermediate positions.
	Mouth opening	The mouth can be closed (**joined lips**) or open more or less widely (**only lips saparated**, **lips and teeth separated and showing**, **lips and teeth separated but teeth not showing**).
	Tongue position	Can be hidden in the mouth or visible with the mouth open more largely.
	Lips alignement	Lips can not seem tense and are aligned, of same length. Other times, the upper muzzle extends to become longer than the lower lip. It is also sometimes angled, in a more or less pronounced way. Gives impression of a tense chin.
	Lip quivering	Both lips are quivering for several seconds.
	Eat	The horse takes vine leaves or gass and chews them. The horse can sometimes take vegetation at the beginning of the vine row and chew them intermittently for a long part of the row. When it's the case, grass or leaves are seen at the corner of its mouth all the while.
	Chew	It seems like the horse sometimes chew without have had any food intake.
	Snort	Forceful exhalation through the nostrils while making a characteristic sound.
	Salivation	Saliva present around the lips.
Head position and movements	**Nose bridge position**	Various degrees of the head-neck-shoulder angle. The angle is assessed based on the position of the nose bridge in relation to the vertical. The angle starting point it at the ear base. At vertical position is equal to 0° angle, all positions in front are positive angles (e.g., 30°), and positions behind are negative (e.g. -10°).
	Neck position	Various degree of neck hight. The hight angle can be describe with the earbase or poll in relation to the withers base. When aligned, the angle is equal to 0°. All positions above are positive angles and positions below are negative angle. Positions can be monitored for instance with these angles: **Very high > 30°; High [+30°;0°]; Low]0°; -30°]; Very Low > -30°**
	Head movement	Turns its head to **look to the right (outside)**, **look to the left (inside, towards the cameraman)**, **look behind**, puts **its head in line with its body**. **Shakes head sideways as if to chase away flies**. **Lowers the head**, sometimes as if trying to catch a piece of grass. **Raises the head high**, sometimes raising it high and tossing it a bit vertically. **Moves the tip of the nose forward,** as if to lossen the reins.

		The head movements can be more or less wide and more or less fast. Sometimes several movements are combined.
Gait	**Walk**	Slow four-beat gait.
	Stumble	Trips without falling. Usually accompanied by a head movement (up/down) more or less broad and rapid, depending on the extent of the loss of balance.
	Stop	The horse is stop moving foward and stands still. Stops can be very brief, less than a second, or be well marked (several seconds).
Tail	**Tail position**	The tail can in any positions from being tight in the middle against the buttocks to falling in a 'natural'way, or looser with a visible gap between the tail hair and the buttocks.
Others	**Dung**	The horse stops to defecate.
	Sweating	Sweat present on the horse after deharnessing, in more or less important quantity. Mainly on the neck, under the mane, on the chest and on the collar and harness.

1.2. Behaviors illustration

Ears position

Foward

Intermediate

Left ear pinna fully visible and right ear pinna symmetric

Ears in 2 differents positions (here one forward and the other intermediate)

Backward

Figure 9. Different horse ears positions

Eye position

Open	Slightly closed	Closed

Figure 10. Eye opening

Sclera

Present *Absent*

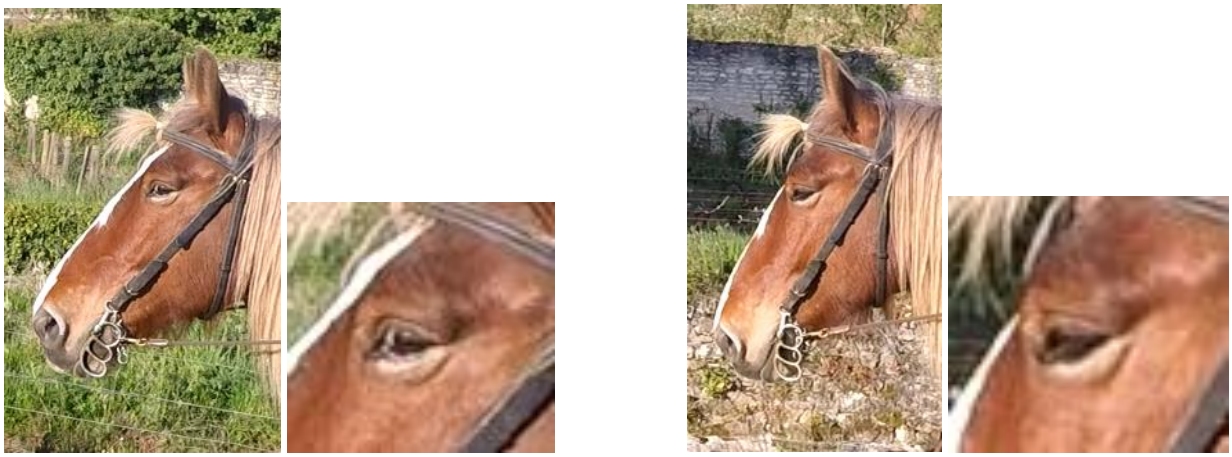

Figure 11. Sclera visible or not.

Nostrils

Teardrop-like *Oval-like* *Round-like*

Figure 12. Different nostril positions.

Mouth opening

Open *Closed*

Lips jointed

Lips saparated

Lips and teeth separated, theeth showing

Lips and teeth separated, theeth hidden

Figure 13. Different mouth positions.

Tongue position

Tongue visible, mouth slightly open | Tongue visible, largely open | Mouth open but tongue hidden

Figure 14. Different tongue positions.

Lips alignment

Lips aligned | Upper lip slightly elongated, forming like two bulges (one at the nostril, and one at the upper lip), angled | Upper lip very elongated and very angled

Figure 15. Different lips alignment.

Nose bridge position

Figure 16. Nose bridge position

Neck position

Figure 17. Neck position

Tail position

Tight | Relaxed, 'natural way' | Gap between tail and buttock

Figure 18. Tail position.

2. Ethogram of potential discomfort behaviors

2.1. Behaviors list

Table 2. Ethogram of potential discomfort behaviors of horses performing weed control operation in vineyard

Behavior category	Name (Code)	Literature mention. this behavior as potentially expressing discomfort	Survey meth. Chosen	Modifiers	Description
Facial expressions	**Ear movement**	(Dalla Costa et al., 2014) (no ears movement)	O		Any movement of the ears.
	Ear backward	(Dalla Costa et al., 2014; Dyson et al., 2018a; Gleerup et al., 2015; van Loon and Dierendonck, 2015)	S	Forward / Intermediate / Backward / Layed flat / None / Cannot tell	Forward: Both ears with pinna facing foward, or side-foward but the full pinna cannot be seen. Intermediate: both ear at middle/vertical position, full pinna is facing the camera or combination of ear position (one foward one backward, one foward one intermediate, one backward and one intermediate. Backward: Both ears with pinna facing backward, or side-backward, but the full pinna cannot be seen. Layed flat: Ears backward and layed against the poll.
	Eye closed	(Dalla Costa et al., 2014; Dyson et al., 2018a; van Loon and Dierendonck, 2015)	O	Open / Closed / None / Cannot tell	Closed: total closure of the eyelids. Open: all the other eye positions.
	Sclera visible	(Dyson et al., 2018a; van Loon and Dierendonck, 2015)	S	Yes / No / None / Cannot tell	Yes: Sclera (white of the eye) is showing quickly. No: eye open and sclera not visible, or eye close.
	Mouth in open position	(Christensen et al., 2014; Dyson et al., 2018a; Górecka-Bruzda et al., 2015)	S	Absent / Moderatly present / Obviously present / None / Cannot tell	Absent: joined lips. Moderatly present: mouth slightly open and closed, teeth not seperated. Obviously present: Clearly open, separation of lips and teeth.
	Mouth openning	(Christensen et al., 2014; Dyson et al., 2018a; Górecka-Bruzda et al., 2015)	O		Mouth opening with separation of the teeth, outside of chewing/mastication following food intake.
	Tongue exposed	(Dyson et al., 2018a)	S	Yes / No / None / Cannot tell	Part of the tongue visible, outside of the food intake (if vegetation visible at mouth coner). Either when mouth opens or when tongue is hanging out.
	Tongue exposing	(Dyson et al., 2018a)	O		Part of the tongue visible, outside of the food intake (if vegetation visible at mouth coner). Either when mouth opens or when tongue is hanging out. One clik per envent, one click each time its hidden and seen again (ex: mouth closes then opens)
	Yawning and/or Fleming	(van Loon and Dierendonck, 2015)	O		Yawning: Opening of the mouth in a yawn, extending the head and neck, eyes rolls/closes and mouth closes. Fleming: horse extends its neck, raises its head, and inhales as it rolls its upper lip back, displaying its front teeth (Ony, 2008)

	Upper lip elongates	(Dalla Costa et al., 2014; Gleerup et al., 2015)	S	Absent / Moderatly present / Obviously present / None / Cannot tell	Obviously present: The upper lip is elongated, the tip is angular, it is contracted, and the nose seems flattened, and the chin tensed, resulting in an edged shape of muzzle. Outside of food intake (leaves visible at the mouth). Moderatly present: Every position where the muzzle is nor well aligned, nor oviously present. The upper lip is slightly elangated, but the tip of the lip is still smooth and round (contrary to angled when oviously present). Outside of food intake (leaves visible at the mouth). Absent: The lips are aligned.
	Salivation		*	Present / absent / None / Cannot tell	Present (visible at least once) or absent on period assessed.
Head position and movements	**Nose bridge position**	(Dyson et al., 2018a) (above 30° and behind -10°)	S	> 30° (Foward) / [30° ; -10°] (Vertical) / < -10° (Backward) / None / Cannot tell	The angle is assessed based on the position of the nose bridge in relation to the vertical. The angle starting point it at the ear base.
	Vertical head movement	(Christensen et al., 2021; Dyson et al., 2018a; Górecka-Bruzda et al., 2015; van Loon and Dierendonck, 2015)	O		Violent (quick, maybe ample) **up/down movement of the head**. (e.i. clear movement of the head away from the desired frame). Exclude movement resulting in food intake (e.g. grass)
	Pull reins	(Górecka-Bruzda et al., 2015)	O		Pulling the reins by bringing the tip of the nose forward and extending the neck (the horse moves its mouth foward).
Gait	**Stumble**	(Dyson et al., 2018a)	O		Stumbles or trips, losses balance, even falls or almost falls. Usually accompanied by a head movement (up/down) more or less broad and rapid, depending on the extent of the loss of balance.
	Trot or Canter	(Christensen et al., 2021; Dyson et al., 2018a)	O		Break gait to trot or canter. Trot: Two-beat diagonal gait of foward movement. Canter: Three-beat gait of foard movement.
	Sudden change of direction or Spooking	(Christensen et al., 2021; Dyson et al., 2018a)	O		Shying/spooking, i.e. the horse shows a startle reaction with a subsequent attempt to flee, sudden change of direction.
	Rearing or bucking or kicking backwards	Dyson	O		Rearing: both forelimbs off the ground. Bucking or kicking backwards: one or both hindlimbs off the ground.
Tail	**Tail swishing**	EQUUS-COMPASS Dyson Christensen 2021 Gorecka 2015	O		Quick lateral/ side to side, dorsoventral/ up and down or circular motion of the tail that interrupts the rhythmical waving motion of the tail corresponding to the gait. One click for each back-forth movement.

O: Occurrence. S: Scan.
*: For the period assessed
None: external factors forbid to see the body part properly to tell if and how the behavior is present.
Cannot tell: the part of the body concern by the behavior is visible but the operator noting the behaviors can't decide on the right modifier.

2.1. Behaviors illustration

Ears backward

See illustrations in the general ethogram.

Eye closed

Open *Closed*

Figure 19. Eye opening modifiers.

Sclera visible

See illustrations in the general ethogram.

Flemen

Figure 21. A horse fleming. ©Waugsberg

Yawning

Figure 20. A horse yawning. ©Stephanie McDowell

Nose bridge position

Figure 22. Nose bridge modifiers positions.

Vertical head movement

Figure 23. A horse shaking its head verticaly. ©SJ Dyson

Ears layed flat

Figure 24. Ears layed flat. © Chunga-Stock

Spooking

Figure 25. Horses spooking. ©SJ Dyson.

Rearing

Figure 26. A horse rearing. ©SJ Dyson

Bucking or kicking backward

Figure 28. A horse bucking. ©SJ Dyson

Tail swishing

Figure 27. Tail swishing. ©SJ Dyson.

Discussion

1. General ethogram

Lips quivering

One horse has been seen lips quivering. It seemed like it was doing it rather during walk than when stopped. For the continuation of the project, it would be worthwhile to see if other horses do this, and to try to qualify the moments when this behavior appears. As the behavior appeared many times during the video, and intermittently, recording each period of lip quivering could be quite time consuming. A first step could therefore be to record whether, over the whole period observed, the behavior appeared or not at all.

Head movements

As described in the ethogram, there is a wide variety of head movements observable in the horse during plowing of the edges. Some of them may be slow and not very wide (e.g., some reins pulling). It is therefore sometimes difficult to identify them. It also seems to happen quite often that several head movements are combined (e.g., shaking the head sideways as if to chase flies, and lowering the head to eat). If we plan to record these behaviors, we will have to put a category for each head movement and record the behaviors that are combined. Thus, this task may be quite time consuming.

The head movement turn your head to the left, towards the cameraman'raises the hypothesis that the cameraman may induce stress in the horses. On another note, some studies suggest that horses are prey animals and may hide their signs of pain or discomfort in the presence of a potential predator (Briant et al., 2017). Nevertheless, several studies that have tested this hypothesis seem to refute it (Gleerup et al., 2015; van Loon and Van Dierendonck, 2018)

Vocalizations

Some snorts were heard on some of the videos, but no neighing. Due to the quality of the audio in the videos, however, it was not possible to determine whether sighing or teeth grinding was present.

Some behaviors were not included in the list because they were not observable due to the framing of our videos (side-view):

On three tracks

"Hind limbs do not follow tracks of forelimbs but eviated to the left or right ; on 3 tracks" (Dyson, 2021, p. 2; Dyson et al., 2018a, p. 53)

Requires a back (or front) view to identify.

Seen during the field measurements.

Figure 29. On three tracks ©SJ Dyson.

Head tilted

Head tilted or tiling repeatedly (Dyson, 2021, p. 2; Dyson et al., 2018a, p. 53)

Requires a front view to identify.

Seen during the field measurements.

Figure 30. Head tilted ©SJ Dyson.

Tail held to one side

Tail held to one side (Dyson, 2021).

Requires a back view to identify.

Figure 31. Tail held to one side ©SJ Dyson.

Due to time limitations, **some behaviors do not have illustrated references** (or in the case of movements, like pulling the reins, do not have a video clip or several frames showing the motion). In order to precisely define these behaviors, it would be needed to do so the next years of the project.

The ethogram we have done is valid for horses observed during their first hour of work. However, it seems that horses express different behaviors after a day of work (Trindade et al., 2020). It can be assumed that the behaviors expressed might be different at another time of the working day, with the fatigue accumulation. It would be interesting to be able to observe horses at work at other times of their working day, for example during the last hours. For the rest of the project, it will probably not be possible due to time and geographic constraints.

Observations were also made only along the rows, **but not on the half-turns**, thus missing a part of the horse's work.

The observations were also based on a rather **small sample of horses.** It is therefore necessary to confirm and continue to enrich this ethogram during the following years of the project. For instance, a quick look at other videos showed the presence of urination behavior.

Only one person watched the videos, so it is possible that there is an observation bias. The videos would therefore benefit from being viewed by at least one other observer. For the continuation of the project, we could also imagine **asking a person working daily with horses to watch some videos**. It is possible that after the hours spent in contact with the horses and their experience, they will notice some aspects that the observer might have missed. One could also imagine showing some of the videos to some of the drivers and noting down their feedback, in the form of **self-confrontation (watching his/her own video) or alloconfrontation (watching another driver's horse video).**

In all cases, it is important to take notes of everything the driver can say during the measurement on the field, because he/she gives information that can be useful later. For example, a driver told us on a plot that one inter-row out of 2 had been ploughed a few months before, and when observing his horse, he could see that he had to force more to pull the plough when he was on the side of the unploughed row. For next year, it will be necessary **to leave the cameras on during all the exchanges with the driver**, and to try to take notes when possible (the audio of the videos does not always capture the sound if the driver is a little far from the cameraman).

2. The ethogram of potential discomfort behaviors

Ears movements

Several studies looking at signs of discomfort in the horse's stall, including the one by Dalla Costa and her colleagues (Dalla Costa et al., 2014), point to the lack of ear movement as a sign of discomfort. However, this behavior may be time consuming to record. Watching the videos gave the impression that there may indeed be differences in eye movement between horses. It would therefore be interesting to explore this behavior. The feasibility of doing so will have to be tested next year.

Ears backward

We have chosen to record the position of the ears as "backward" as soon as the ears go backward beyond the vertical and the pinna of the ear is no longer completely visible, while a combination of one ear backwards and one ear in another position is recorded as "intermediate". However, some ethograms found in the literature state that even when there is only one ear back, it can be interpreted as a sign of discomfort (Dyson et al., 2018a; Gleerup et al., 2015). It would therefore be necessary to isolate this

position from other intermediate positions. The problem with our videos is that the right ear is not always visible. It could be that we cannot distinguish when this ear is backwards. We will have to think about whether next year it is finally decided to include the case where only one ear is backwards in the " backward " modification.

The article by Dyson and colleagues (2018a) is also clear that the ear(s) must be held back for at least 5 seconds to be considered a sign of pain. It might be an idea to try to note in occurrence as soon as one or both ears are backwards more than 5s, in parallel of the scans. The article also mentions repeatedly layed flat ears. This behavior has been included in the modification of the scans, but it would be interesting to try to note it in occurrences. It is a behavior that has not been seen in the 6 videos observed, one can imagine that it happens quite often, and that it will therefore require little time to record in occurrences. When interpreting the position of the ears, it is important to keep in mind the effect of the commands given by the handler. Indeed, it has been observed that horses turn their ears backwards when the handler speaks.

We decided to include behaviors not seen in the general ethogram (ears layed flat, tail swishing, sudden change of direction or spooking, rearing or bucking or kicking backwards, trot, canter, yawning, fleming) in case they appear in other videos.

Eye opening: half-closed

The eye half closed (or partially closed) is described as linked to discomfort (Dalla Costa et al., 2014; Dyson et al., 2018a; van Loon and Dierendonck, 2015). However, it was hard to be able to tell differentiate the half-closed position, even more when the videos were backlit. Eye partial closure can also be linked to meteorological conditions such as wind and sun. Four of the videos we observed took place on a sunny or windy day. Such conditions were common during measurement taking on the field. We thus decided to take out this modifier, and only differentiate between an open or closed eye.

Lips not aligned and Sclera visible

One of the horses observed gave the impression that his lips were never aligned. One wonders if this is due to the fact that the horse has really kept his lips contracted, or if it is their natural position. For next year, it would be necessary to take a photo of the horse in profile (ideally the left profile, to have the same profile as the one visible on the videos) to look at the natural position of the horse's lips.

Similarly for the sclera, Dyson (2021) pointed out that some horses have a small iris, so the sclera can be seen at rest without it being linked to any discomfort. Also, a photo of the horse's left profile can help to decide.

In our ethogram, we suggested recording the appearance of the sclera, although this is an event that is often brief. This choice was motivated by the observation that it was too complicated to distinguish the presence of the sclera while watching the video (point of view a little far away, luminosity or annoying contrast) and that it was necessary to pause the video to realize it.

Still concerning the sclera, Van Loon and Dierendonck (2015) underlined the fact that it can be visible during head/eye movements. It is therefore necessary to take this aspect into account when interpreting the signs of discomfort, by trying for example to cross-reference the appearance of the sclera with head movements.

Mouth opening (in open position)

We observed in our videos a range of mouth opening. The mouth opening is interpreted as a discomfort behavior when teeth are separated (Dyson et al., 2018a), but in the paper from Christensen et al., (2014), a slightly open and closed mouth is also described as discomfort behavior. It could then be considered for the next year of the project to include an intermediary position.

One paper specified that in order to be considered an disconfort behavior, the mouth should be opening and shutting repeatedly, for more than >10 seconds (Dyson et al., 2018a). For next year, the feasibility of recording this behavior in occurrences should be tested (one click each time the mouth is opening or shouting for more than 10s).

We chose to record the mouth opening in scan and in occurrence, because we observed on the videos mouth openings that lasted several seconds as well as shorter openings. The combination of scans and occurrences allows us to see these 2 aspects of this behavior. Similarly, for the language, it seemed that the language was visible sometimes very briefly, and sometimes for longer periods. The combination of scan and occurrence also seemed to be suitable.

In addition, Dyson (2018b) specified that the mouth openings can be linked to actions too strong on the reins. The viewing of the 6 videos gave the impression that there could indeed be a link between the actions of the leader and the mouth openings. In fact, for next year, it seems important to explore this track by recording the orders given by the leader, and if possible, the actions on the reins. The actions of the reins could be recorded by placing a dynamometer on each rein.

Tongue

In our definition, we included as 'tongue showing' the times when it is visible because the mouth has opened. Only, in a definition found in the literature (Dyson et al., 2018a), they only counted when the tongue was exposed, protruding or hanging out. It is unclear whether this definition only includes cases where the tongue actually comes out of the oral cavity, or also times when it remains in the oral cavity but is visible because the mouth is open. For next year, we will have to decide if we want to stay with our

definition or change to a definition focusing on the cases where the tongue clearly comes out of the oral cavity.

Lips elongate

The mention 'outside of food intake' was added because the horses have been seen on the videos using their lips to gather and chew vegetation.

The descriptions found in the literature partially overlap with the modifiers we have chosen here. In the literature, it is rather described as an**"** *increased tonus of the lips and tension of the chin resulting in an edged shape of the muzzle".* (Gleerup et al., 2015, p. 109), "*Lips elongate and the nose flattens"* (Dalla Costa et al., 2014, p. 5) or **"***the profile changes and you can see two bulges (one at the nostrils and upper lip) "*(Dalla Costa et al., 2016, p. 4). Lip tension seems to have a link to some degree of disconfort. Thus, it was decided to monitor it as described in the ethogram of potential discomfort behaviors, but literature should be consulted again when it comes to interpreting this sign of discomfort.

Some behavior, like 'lips elongates' included modifiers **'obviously present', 'moderately present' and 'absent'**. This way of naming the modifiers, and the addition of 'moderately present', contrary to only 'present' or 'absent' was found by the observer to be helpfull when behaviors are not strongly expressed (such as the lip moderately elongating).

Head movement

An article states '*Head position changes regularly, tossed or twisted from side to side, corrected constantly*' (Dyson et al., 2018a, p. 53). This behavior was not explored for inclusion in the ethogram, but for next year, it would be possible to see if it is easily observable and recognizable by the observer, to possibly include it.

Salivation

It was chosen to include salivation as an exploratory behavior, to see if later on, this behavior seems to be present in the sessions where the horse expresses more discomfort behaviors than others. This behavior is not based on bibliographical references, but rather on an impression felt during the measurements, which will need to be confirmed or invalidated in the continuation of the project.

Stumble

This one was included because seen in some videos. However, depending on the head camera angle and the vegetation, it can be challenging to tell. In addition, the vineyards grounds were often uneven (holes,

mounds, stony). As noted by Dyson and her colleagues (Dyson et al., 2018a), the soil surface can disturb the hors'se footing, resulting in stumbling not caused by discomfort.

Vertical head movement

As seen in the general ethogram, it happens that the horse has a downward movement, very direct towards the ground, in the same movement as to go grazing. However, the movement is not completed, and the horse raises its head. When we listen to the videos, we have the impression that it is linked to a request from the driver to go forward again. It is as if the horse tried to graze but was stopped in its momentum. Still, this behavior counts as a vertical head movement. For next year, we could think of adding a modality of the head movement as "attempt to graze", and then cross-check with the actions of the leader and the other behaviors to decide if this behavior is close to a will to graze, or if it is really a head movement of discomfort.

Neck position

We noticed during the construction of the general ethogram that there were variations in neck height. No sign of discomfort was included in the ethogram, because the literature that mentions this behavior associates it with a horse in the stall with a low neck, prostrate, depressed (van Loon and Macri, 2021). This does not seem appropriate for work in the vineyard. Nevertheless, we could consider including this behavior next year, rather with the idea of quantifying the neck positions visible in the horses observed, but without giving any interpretation as to a sign of discomfort. It would be interesting to explore the use of an angle tracking software, such as Kineveo, to record this behavior. However, it seems that the observation can be done well without this software, using for example this type of device:

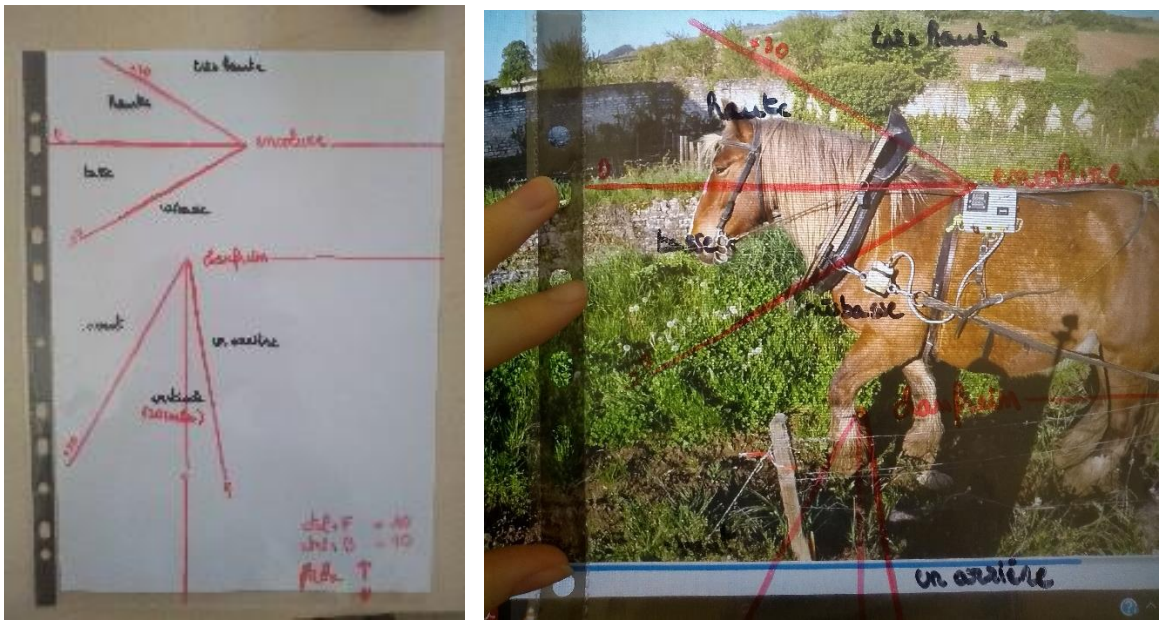

Figure 32. Use of a template drawn on a plastic sheet to measure the angles

Regarding trot and canter, we included it as "breaking the gait to trot or canter" because following discussions with the drivers, they precised that they only ask their horses to walk during work. Any faster gait is considered spontaneous. If we observe trot or galop next year, it may be appropriate to consult the horse leader to confirm that this change of gait is spontaneous.

Some behaviors were not included in the ethogram because they were not appropriate for the activity, or not visible:

Canter repeated leg changes

Canter repeated leg changes : repeated strike off wrong leg ; change of leg in front and/or behind ; crooked ; disunited (Dyson, 2021, p. 2; Dyson et al., 2018a, p. 53)

The horses observed are not worked at the canter.

Figure 33. Canter repeated leg changes ©SJ Dyson.

A rushed gait

A rushed gait (frequency of trot steps > 40/15s) ; irregular rythm ; repeated changes of speed (Dyson, 2021, p. 2; Dyson et al., 2018a, p. 53). The horses observed are not worked at the trot.

Gait too slow

Gait too slow (frequency of trot steps < 35/15 s) passage-like trot (Dyson, 2021, p. 2; Dyson et al., 2018a, p. 53). The horses observed are not worked at the trot.

Tail clamped to the middle or to the side (see previous part).

Nostrils

Nostril dilation as a discomfort behavior has been explored. Nevertheless, the articles that mention it are all based on the observation of horses in their stalls (Dalla Costa et al., 2014; Gleerup et al., 2015; van Loon and Macri, 2021). However, we are horses practicing a physical activity. Knowing the strong influence of physical effort on nostril dilation, it was decided not to include this behavior in our list.

Repeated bilateral hindlimb toe drag (Dyson et al., 2018a)

The framing is too high and the vegetation on the vine does not allow to see this behavior.

A paper mention the behavior of **being reluctant to move fowards** (has to be kicked +- verbal encouragement) (Dyson et al., 2018a). However, without much more context and description, we found it quite challenging to determine this behavior.

This same article also mentions **spontaneous stops by the horse**. However, after discussion with the drivers, we realized that these horses are taught to stop when they feel too much resistance in their collar,

to avoid tearing off a vine when the plough gets stuck in it. It is therefore not possible to differentiate learned stops from completely spontaneous stops. Therefore, this behavior was not included.

None & cannot see

We have included 'None' and 'Cannot see' modifiers to identify cases where the behavior is not observable because of something external to the observer (e.g., poor framing) and cases where the observer cannot judge, as we have noticed that it is sometimes difficult to differentiate between some very similar behaviors (eg. Lips very elongated and lips slitghly less elongated). Mullard and their colleagues express this idea as following:

The importance of introducing the score "Cannot see" in developing an ethogram of facial expressions is highlighted by these results and adaptations […] and also takes more account of human error and chance scoring. Some previous studies did not incorporate this "option" when assessing interrater reliability or ethogram validity. (Mullard et al., 2017, p. 11)

Scan frequency

Several behaviors are noted to be noted in scanning. The question of the frequency of the scans has been raised, without a definitive answer. On the horse side, no literature was found on the frequency of scans adapted to be representative of reality. It might be appropriate next year to see if elements are available in other species.

It was tested in an exploratory way to make scans every 5s, but the process was extremely time-consuming (a vineyard of hours for 10min of observed video). For next year, if no reference is found, a scan frequency every 10s seems to be more feasible. Nevertheless, by scientific rigor, it would be necessary to at least test to make scan frequency of 1s on for example 5min of a video, and to compare the results obtained when one goes up to 5s then 10s.

Technical limit

Figure 34. Two different images for the same time code.

It has been noticed that the software used for video processing (Boris) can display 2 different images for the same timecode, from one time to another, with a shift of a few milliseconds. For fast behaviors like mouth openings, this can change the observed result from one click to another on the same timecode (Fig.34).

Methodological advice

In order to be able to compare the appearance of discomfort behaviors between videos, it is necessary to calibrate the duration of observation. However, the duration of work in the vine row and the duration of the half-turns are different according to the videos. For next year, it would therefore be necessary to add a time-budgeted **record of "work in the row**", counting from the beginning to the end of each side of the row worked. The beginning of the row could be marked at the first request of the driver to ask the horse to move forward, and the end of the row could be marked when the plow leaves the row.

Apart from the viewings where we try to note the orders given by the driver or possibly the sounds emitted by the horse, it would be good to **watch the videos without the sound,** precisely to not be influenced by these factors.

During the behavioral survey, it is useful to **have a document on which the observer marks comments or hesitations or feelings about the observation**. This allows the observer to follow the evolution of the observation process and to receive information that can be transformed to explore. This can also be done by adding to the Boris software a "behavior" called "other", for example, in which one takes note of these feelings or difficulties as comments. For instance, for one video, it was noted on a side sheet that “The snorts are only heard while descending the row, and not during the ascent. However, the descent also corresponds to the direction of descent. In this direction, the horse also had the headwind. Is the snorting caused by the headwind blowing air into the nostrils? Or is it that the horse has made an effort during the climbs, and is "blowing its nose" from this effort it made during the during the ascent, as it happens to expectorate after a race?” This feedback can be used to hypothesize that there is a difference in the appearance of certain behaviors, such as snorting, between going up and going down a slope.

Some pieces of video are backlit, making it difficult to distinguish eyes, sclera, mouth, tongue. It was discovered that **using the tool “Capture d’écran windows”, it enhances the image luminosity**, helping a bit to better distinguish some parts in the backlight.

The videos were sometimes taken from too high an angle, making it difficult to see the mouth and lips (Fig 35). The videos were also sometimes taken ¾ of the way through, making it difficult to judge the alignment of the lips. **For next year, it will be necessary to lower the cameras on the mast of the harness, so that the head camera is more at the height of the head of the horse. It will also be necessary to keep the head camera perpendicular to the horse head.**

Figure 35. Camera angle taken from too high. Mouth and lips not distinguishable.

The horses observed often had voluminous manes and forelock, hiding the eyes. This phenomenon was accentuated when the wind brought all the hair in front of the eyes. **For next year, it will be necessary to braid or tie the forelock** (Fig 36).

Figure 36. a) Forelock braided. b) and knotted.

As mentioned above, the inter and intra observer reproducibility of our ethograms could not be tested. Nevertheless, concerning the ethogram of pain indicators, we tried to sort out only recognizable behaviors given the angle and quality of the videos, to specify extensive definitions, and to add illustrations when possible. We have also added the mention of the "none" and "cannot tell" modifiers and given methodological advice. **We hope that all these elements will help to ensure good inter and intra observer reproducibility.**

These ethograms are a first step and will have to be specified and enriched as new observations are made. **An ethogram cannot be exhaustive, but it can evolve** (IFCE and LARCHER, 2015).

If one wants to interpret these potential signs of discomfort, one must keep in mind the effect of the horse's age and experience on behavior. It might even be interesting to see if there is a pattern. Indeed, younger horses would tend to express more conflict behavior (Dyson et al., 2018a).

The horses in the study are also observed working on very different plots, under very different weather conditions and with different drivers. For next year, it could be relevant to add to the protocol a step of video taking before the work. **It would consist in filming the horse as it is during its work, walking between the rows of vines, but without the plow behind.** Comparing this video with the video with the plow attached could give an indication of the effect of pulling the plow all other things being equal.

The choice was also made to group the marker behaviors of any type of negative experience under the scope of discomfort behavior, because the **differentiation between fear, pain, and other sources of distress may not be clear** (Hall et al., 2013, p. 63).
In any case, considering the number of elements influencing the comfort or discomfort perceived by the horse (see introduction '…which brings with it its share of challenge'), **it will be necessary to remain cautious on the conclusions, and first try to compare if there are differences of expression between the horses, before trying to explain them**.
For next year, it would make sense to try including the behaviors of the general ethogram in the ethogram of discomfort in order to track all the behaviors appearing, and then try to see if some behaviors are linked (e.g., appearing a lot in the same videos).

As Hall and his colleagues point out, improvements in animal welfare require not only the absence of negative experiences, but also the promotion of positive ones (2013)**.** This report has focused on behaviors that indicate discomfort, but it would be legitimate to ask **whether there are behaviors that indicate comfort.** Research in this area is in its infancy. Historically, researchers first looked for evidence of suffering or pain, and only recently have they turned to comfort markers (Briant et al., 2017). There are very few of these, and further study is needed to explore this avenue.

The focus was also on horses during their working time, but there are tools built to try to perceive the general state of well-being of horses. **One example is the "Cheval bien-être" protocol** (Horse welfare), which was developed on the basis of the research of the Welfare Quality® protocol (BRIANT and ifce, 2022). This protocol gathers sanitary, zootechnical and behavioral indicators, looking at the horse outside the working time. This protocol is based on the idea that the accumulation of negative elements, even during work, should, at a certain stage, be reflected in its condition outside of work. For the continuation of the study, it would be interesting to explore the applicability of this protocol to our case study.

Conclusion

In this master's thesis, we have elaborated an ethogram of draught horses plowing down ridges in the vineyard by observing videos of these horsing working, and by providing the most precise definitions and illustrations possible. We have then searched through the literature to find an article mentioning behaviors potentially linked to discomfort, we have sorted out these behaviors, choosing those adapted to the activity performed by the horses we observed, and separated those that were observable on our videos. We also tried to enrich and clarify the existing definitions in the literature, and if possible, to image them. Nevertheless, for the continuation of the Caract-Equivigne project, it will be to finish illustrating the behaviors which could not be illustrated in this report and to continue to enrich these ethograms. During the elaboration of these ethograms, some technical and methodological challenges have been encountered, and we have tried to bring some keys to face them next year. Despite these first tracks, it is also necessary next year to continue to test the method, in particular by calling upon another observer, to confirm the inter and intra observer variability. Finally, we raised the possibility of recording all the horse's behaviors (including discomfort), to try to identify the behaviors appearing in number on the same videos.

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Appendixes

Appendix 1. Selection of vineyards, driver-horse pairs and vine plots (selection throughout metropolitan France):

- Intervention of the horse every year on the estate and the will to continue horse traction at least until 2023;
- Selection of estates (and plots) with a history of at least 3 years of horse intervention for soil maintenance;
- Minimum of 5/6 days per year of horse intervention on the estate;
- Total surface area of the estate of at least 2 hectares;
- At least 2 plots worked by the horse with either 2 different soil maintenance itineraries (100% horse or mixed horse and tractor), or having a different topography, or having a different soil type;
- At least two interventions per plot studied: ridging and de-cultivation;
- If possible nearby (on the estate or in a neighbouring estate), a control plot where the horse does not intervene (with a similar soil type), mechanical tillage carried out by a tractor
- Motivation to participate in the project as it will require some time.

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