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How to transform pesticides exposure of agricultural workers ? : Towards a prevention process centered on developing the leeway of people at work

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Abstract: *Farmers and farm members (employees and families) are exposed to pesticides despite preventive measures. The fact that exposures related to certain substances mixed in plant protection products are not directly perceptible do not let humans to control exposure, as well during the operations required when treating the crops that for the situations of indirect exposure during post-preparation and post-application tasks. The objective of our ergotoxicological research-intervention has been to find ways to involve wine compagnies and their stakeholders to better detect and transform pesticides exposure situations. Focused on understanding exposure situations, the shared metrology of pesticides developped at the heart of wine-growing activity aims to research the factors of the risky situations in order to propose their transformation. These factors have been sought by a participatory approach at the scale of work operations, at the spatial scale of farms, but also outside wine-companies scale, where the prescribed rules of work are designed. The analysis of these factors has made it possible to demonstrate that preventive actions allowing workers « to gain leeway in the conduct of their activity » should be developed to better support the prevention of pesticide risks in a dependent occupational and social environment.*

Keywords: *pesticides exposures, agricultural activity, ergotoxicology, collective action, person-centred risk prevention*

Introduction

The health consequences of agricultural pesticide exposure have drawn increasing concerns and are a sensitive political and media issue. The epidemiological data summarised in the French National Institute of Health and Medical Research report (Inserm) (Baldi *et al.*, 2013) highlighted links between certain chronic illnesses and occupational exposure to agricultural pesticides (a high likelihood that these pesticides contribute to the appearance of several neurological illnesses and some cancers; Parkinson's disease, prostate cancer, malignant non-Hodgkin lymphoma including multiple myeloma). The collective expertise of the French National Agency for Food, Environmental and Occupational Health and Safety (Anses) (Laurent *et al.*, 2016) which highlights the current gaps in the governance of these professional risks demonstrates "the need to analyze the exposures of individuals taking into account practices to grasp the elements that combine in the concrete work situations (Laurent *et al.*, 2016: 27). In concrete work situations, farmers can be confronted simultaneously with multiple physical, chemical and biological risks but also with strong organizational and psychosocial constraints (Fourneau *et al.*, 2018). The multiplicity and concomitance of exposures can favor the occurrence of pathologies and accentuate painful conditions at the work for farmers end their entourage.

In order to construct safety situations for plants protection product users and their entourage, the ergotoxicological intervention (Villatte, 1983, 1985; Sznelwar, 1992; Mohammed-Brahim, 1996, 2000; Garrigou *et al.*, 2008; Mohammed-Brahim & Garrigou, 2009; Garrigou *et al.*, 2010, 2020; Garrigou, 2011; Galey *et al.*, 2019) could not be limited to identifying the determinants of exposure to pesticides at the scale of work operations. Here we present the results of a cooperative action

which made it possible inside agricultural activity to make desirable changes for farmers possible related to product plant protection use. This cooperative action, developped between scientists and farmers, and based on a share metrology approach, has been implemented to better understand the factors of the exposure situations inside wine-companies.

Method

Ergotoxicology, along with other disciplines, enables the characterization of exposure and the prevention of chemical risks. It is now recognized by the need to integrate elements related to work activity in the analysis of occupational exposures (Galey, 2019). Alongside toxicological and epidemiological experimental standards, which support a macroscopic characterization of occupational exposures and the production of general data, the observation of actual work, specific to "the ergonomics of the activity", is complementary. The analysis of exposure at the level of work situations empirically builds a detailed characterization of exposures and thus contributes to the production of specific data to equip risk prevention with a transformative aim.

From an ergotoxicological point of view, simultaneous or successive exposure to several hazards can occur in work situations (Garrigou, 2011). In this context, the approach consists in operating an articulation between different traditionally separated exposure families and looking at the work situation "at the crossroads of risks" (Jeffroy ane Garrigou, 2011). It is then a question of coupling the toxicological analysis of the dangers (present in the situation observed) with the ergonomic analysis of the activity. Metrology is used to objectify certain exposures (Garrigou *et al.*, 2006; Garrigou, 2011) but also to assess certain forms that may be difficult to detect in the snapshot of the observation. The coupling of quantitative and qualitative data is proving particularly effective for understanding exposures and discussing them within the company and its various departments (Judon, 2017).

The action referred to in this document has been developed Inside 5 french wine-companies based on the ergotoxicological approach. The collective action was more precisely deployed in 6 main step (Figure 1). This project involves preventing pesticides exposure by introducing stakeholders to an individual and collective learning process and by ensuring the conditions required for their mobilization (Step 0). After a short observation of the technical and the social context related to the use of plants protection products (Step 1), the research-intervention team has constructed an intermediate discussion object (Vinck, 1999, 2009) to discuss and to analysed the use of product plant protection and the pesticides exposure factors at the scale of the operation (preparation and application tasks) (Step 2). The intermediate discussion object (filmed sequencies of work and exposure) has been next developed and used to discuss exposure situations at the scale of the farm with farmers end their entourage (Step 3), plus, to find out how to prevent them while allowing farmers to improve performance in managing their agricultural activity (Step 5). Technical tools from a complementary approach between ergonomics and toxicology, called ergotoxicology, were used by farmers to assess situations of exposure to pesticides (Step 4) and to discuss their possible transformations inside the multiple risks concerning agricultural activity (Step 5 and 6). In this context farmers have been trained to use the metrology instruments and have contribued to decide in wich purpose “work activity integrated at measurement” could be efficient for risk prevention.

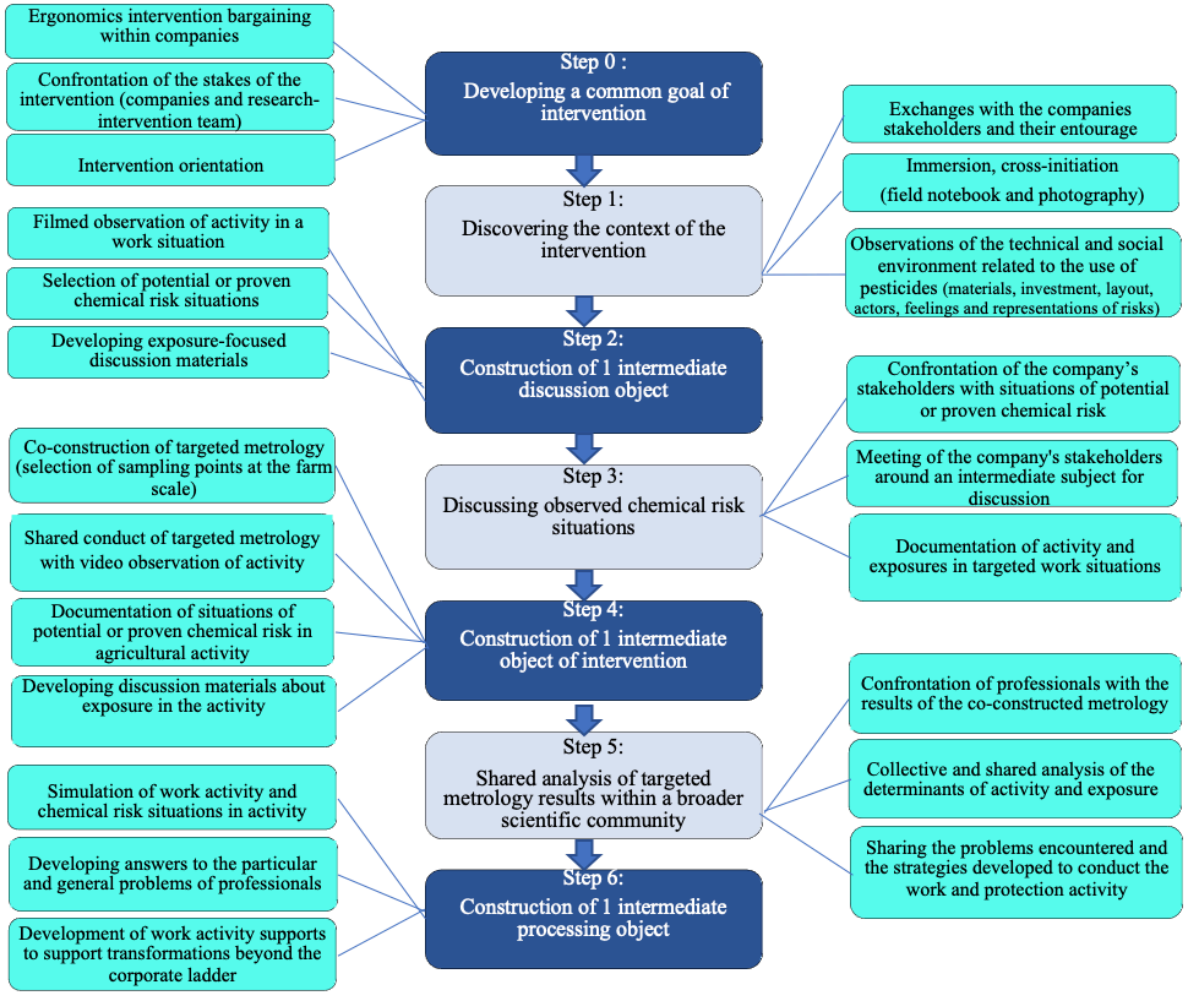

Figure 1. Research-intervention method implemented with companies step by step*. Source: Goutille, 2021.*

Concrete problematic work situations

We have collectively analyzed the product plant protection use and the pesticides exposures inside real work situation. This research-intervention enabled to understand the strategies deployed by the workers to conduce their activity, what they implement relating to pesticides exposures and how they view it prevention and health in the viticulture sector. Our hypothesis is that the reducing of pesticides exposures will be possible all the more rapidly if the pesticides risk governance complies with actor reality and work condition inside a favourable context. Thus, we associated a pesticides risks situations study (mixing of ergonomics with metrology inside the ergotoxicological approach) with an viticulture system study (based on producer's practices) in order to identify problematic situations for farmers. On the one hand, these problematic situations have been used as intermediate objects (Vinck, 1999; 2009) to support group discussions with the stakeholders but on the other hand, they have also represent an object that the actors have been able to adapt to their personal case to initiate appropriate transformation.

Results

Our results coming from the various wine-companies show that conducting a collective action based on real personal problematics and occupational preoccupations could support transformations of exposure situations. These transformations were made possible by a collaborative process of linking public health issues with occupational health issues and co-construction between ergonomics researchers and farmers. There are many pesticides exposure situations linked to the use of plant protection product (Figure 2) but, to select the pertinent determinant to transform into actions (organisational's measures, technical's measures and human's measures) it is necessary to let the farmers design the transformation or to let them to contribute to the design of their work activity (material, prevention rules, etc.). In our opinion, this constitutes a path to follow for accompagning farmers to develop ways to maximize their activity reducing occurrences of pesticides exposures.

Figure 2. Exposure situation during pesticides preparation operation.

The approach that we defend consist to engage agricultural workers involved in hazardous situations in the design of health and safety work situations.
Learning processes developed and encountered along the collective action, including work-group and person centered approach, are based on various intermediate objects like work-sequences video (Figure 3), pesticides collective measures (Figure 4), work simulation in work-group (Figure 5). This is how the members of the collective (farmers and researchers) have developed operational learning processes which will help to adapted their future action strategies regarding activity transformation and risk prevention.

Figure 2. Work-sequences video.

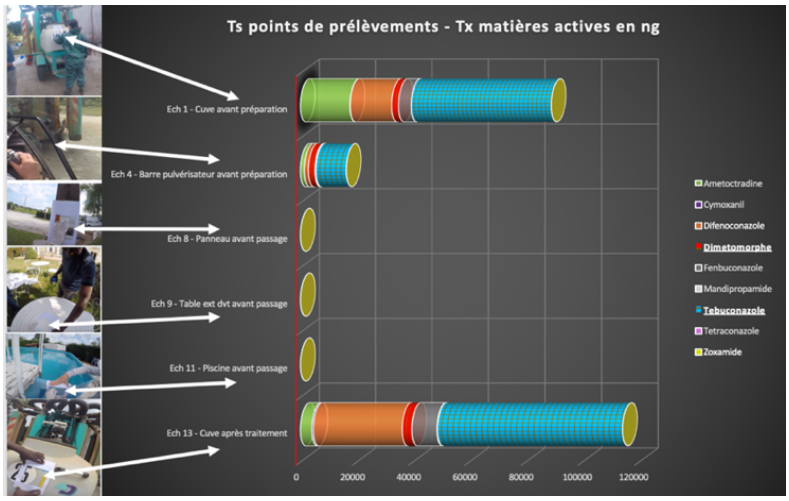

Figure 3. Pesticides collective measures.

Figure 4. Work simulation.

To transform pesticides exposure situation we can first recommand to better include the real activity of farmer inside the risk evaluation. Understanding the real work and the real activity of farmers has allowed to better characterize exposures and their technical, organizational, human and social factors at different scales. In fact, exposure to pesticides and the various exposure factors (physical, social, psychosocial risks) can be characterized by documenting both the professional and private activity of farmers (in terms of treatment operations and in terms of farm management activities) (Figure 6). In this case, developping “discussion spaces”, based on an analysis of the real activity of farmers, and supported by intermediate objet (vidéo, measures, etc.), permit to better document exposure and prevention in terms of factors and variability.

Secondly, it is necessary to support farmers in the construction of measures and transformations adapted to their needs and concerns by integrating scientific resources on pesticide exposures to their practices. Basing to the construction of prevention tools on the real work of farmers has enabled to develop safety situations that combine health and economic performance issues. Conducting a collective action of pesticides measurement permit us to developped our ergotoxicological approach empowering farmers to interact with low-perceptible pesticide exposures inside and outside work activity, meaning between occupational and personnal activity.

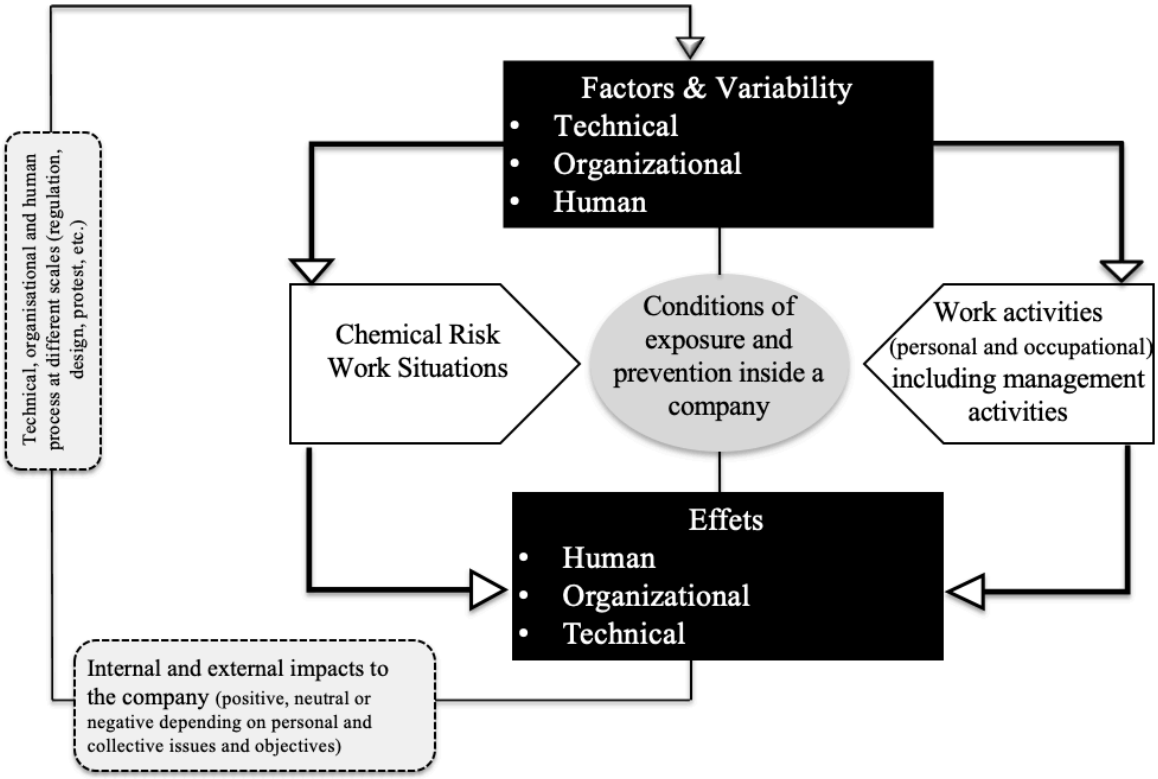

Figure 6. ***Conditions of exposure and prevention in the ergotoxicological model: an interaction between activity factors and factors of chemical risk situations****. Source:* Goutille, 2020.

Conclusion

We conlude from our results that is needed to continue to consider real work and to make possible a person-centred approach (linking occupational and personal activitues) inside work health interventions in order to more effectively prevent different forms of risks to human health. Group work and person-centred risk prevention allow to transform problematics situations for farmers beyond pesticides risks. However, this partnership is not a natural mechanism simply based on the common pesticides risk issue. The partnership needs to be based on what make sens and procure health for farmers. Supporting the transformation of risky situations include to consider the farmers as initiators of the change. The ergotoxicological approach person-centred can help the risk prevention gouvernance\'s change in this way.

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