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How to Ignore What One Knows
Domesticating Uncomfortable Knowledge about Pesticide Poisoning of Farmers in France

François Dedieu
Jean-Noël Jouzel

Abstract. Current research into the social construction of ignorance holds either that ignorance is produced by conscious strategies or is an unintended effect of knowledge production organization. This article moves beyond that opposition by taking into account the reflexivity of actors operating within the organized systems that produce ignorance. What happens when those actors become aware of flaws or limitations in the routines that structure their action? What change dynamics are triggered by this new awareness? The case studied here is arrangements in France for protecting farmers from being poisoned by the pesticides they use. We show how the ban on sodium arsenite that went into effect in France in 2001 allows actors to tolerate "uncomfortable" knowledge of the sort that calls into question the ordinary institutional arrangements surrounding the ban. We bring to light the mechanisms by which the organizations that produce this uncomfortable knowledge also provide their members with "good reasons" to ignore it, defusing or neutralizing their critical faculties and impeding moves to make the institutional changes that should follow from that knowledge.

Keywords. Production of ignorance—Pesticides—Farmers—Occupational health—Risk assessment

Why does it take so long to become aware of the health impact of products known to be toxic such as tobacco and asbestos? Why does it take so long to demonstrate their harmfulness? These questions are the driving force behind a field of research on the production of ignorance in public health. Following Robert K. Merton's pioneering study of incomplete knowledge (1987), Mary Douglas's on institutional memory (1995) and Niklas Luhmann's on the ecology of ignorance (1998), these studies work to show that, contrary to widespread understanding, ignorance cannot be defined as the mere absence of knowledge (Heimer, 2012) or an "original void" (Proctor, 2012) that can be filled by newly acquired knowledge, but may instead be the product of social construction, a move by individual or collective actors to pay attention to some available information and disregard other information. Ignorance here refers to situations where knowledge available for guiding action is simply not used.

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According to one set of studies in this area, ignorance is the product of conscious strategies by actors who have something to gain from maintaining unawareness of the risks involved in given substancies or technologies. Naomi Oreskes and Erik M. Conway's *Merchants of Doubt* (2010) and Robert N. Proctor's study of tobacco companies (2012) have shown how the tobacco industry, on the grounds of what it claimed to be more rigorous scientific research than that being done by its opponents, worked to keep the question of whether cigarette smoking was hazardous to health open as long as possible and to sustain doubt. In the last few years, a new approach, combining sociology of science and political science, has been putting forward an alternative interpretation of situations where ignorance of health and environmental risks is claimed, an interpretation that instead emphasizes *involuntary* and systemic means of producing ignorance. These studies show that the organizations in charge of assessing and monitoring risk are structurally dependent on scientific disciplines and tools that orient how they see—or fail to see—the dangers that it is their job to prevent. The tests and standards these organizations use supposedly enable them to measure—and so to control—the dangers. But they also reduce the ecological complexity of those dangers down to their most readily quantifiable dimensions. Authorities in charge of assessing and managing health risks end up learning "more and more about less and less" (Frickel and Edwards, 2014: 223). In the long run, this tendency to focus on numbers works to "institutionalize ignorance" (Kleinman and Suryanarayanan, 2013) by systematically excluding available knowledge that is not compatible with the routines used by public authorities to identify and prevent health risks.

The literature on involuntary ignorance production offers stimulating insights into the causes of the non-knowledge surrounding certain risks. However, and paradoxically, despite the fact that these studies often describe ignorance as the product of a type of "organization" (Frickel and Edwards, 2014) that allows for picking and choosing from available knowledge, they do not draw on insights from the sociology of organizations. There are in fact two blind spots to this research, and they are the subject of this article. First, authors of studies on the involuntary production of ignorance seem themselves to ignore the reflexivity of the actors they study, whereas reflexivity has been a central dimension in classic sociology of organizations (Friedberg, 1993)[1] and institutions (Fligstein and McAdam, 2011)[2] since Anthony Gidden's work on the "duality of structure" (1984). Because these studies emphasize matching between knowledge and risk management "policy frameworks " they do not take into account risk prevention organization actors' ability to critically view the tools they use to fulfill their missions. They have no trouble imputing ignorance production to "involuntary" dynamics, because the actors they study seem entirely devoid of any will of their own. And yet it seems reasonable to assume that actors using tools such as in vivo tests to measure environmental substance toxicity are at least as aware as political scientists and sociologists of dimensions that are missing from their scientific and regulation-related production. We can therefore reasonably assume that they can use that reflexive ability to raise questions that their routine use of those tools tends structurally to leave in the dark,

1. Erhard Friedberg uses "autonomy" rather than "reflexivity" to designate actors' ability to take a critical view of the regulatory structures they belong to (Friedberg, 1993: 223).

2. Neil Fligstein and Doug McAdam (2011) put reflexivity at the core of their program, but their aim is to propose a broader social theory in which society is conceived of as a set of "strategic action fields."

and therefore that they can set about changing their institutions. This leads us to the second, complementary question that is likewise absent from studies of involuntary organized ignorance, and that is, how do organizations react to criticism, which inevitably involves using reflexive ability, when what the criticism reveals are areas of ignorance actually produced by organization routines? An entire current of research into secrecy production in organizations has gone some way to providing an answer. Diane Vaughan's study of organization secrecy (1996) shows how task specialization and geographical and social separation led NASA workers to ignore accident warning signs during the launch of the Space Shuttle Challenger in 1986. More recent studies adopt a Weberian perspective in which secrecy is understood to be an inherent characteristic of bureaucracies; they show how government bureaucratic structures continue to keep secrets regardless of how much their members may know of them (Maret and Goldman, 2008).

With these remarks in mind, we examine here an ignorance producing mechanism that has not been widely studied, focusing on how the organization provides its actors with resources for legitimating and perpetuating ignorance and continuing not to take into account or integrate surprise events. Our subject is policies for preventing occupational diseases related to farming pesticides. France is one of the world's main users of "plant protection products" for protecting crops and increasing yields.[3] Farmworkers in France are heavily exposed to such products, which are, by definition, toxic for living organisms. However, their pathogenic effects on workers remain stubbornly invisible. The farming branch of the country's national health insurance system has recognized a few dozen occupational diseases as due to pesticide exposure, but those figures seem very low compared to available data (Jouzel and Prete, 2013). The first epidemiological studies on the question in France only got underway in the late 1990s, and their results are fragmentary.[4] And yet, epidemiological studies on the same issue in other countries highlight a clear connection between occupational exposure to pesticides and a number of neurodegenerative diseases (most notably, Parkinson's disease) as well as blood and bladder cancers. These data were obtained in agricultural contexts that differ from the French ones in terms of affected population and cultural practices and are therefore difficult to extrapolate from, but they do suggest massive under-recognition of the occupational disorders linked to pesticide exposure.

In an earlier article (Jouzel and Dedieu, 2013), we showed that the failure to recognize those disorders as occupational diseases was due in part to unintentional ignorance production dynamics in the organizations in charge of protecting the occupational health of farmers and farmworkers. The most important of these organizations are the Ministry of Agriculture and the farming branch of the health insurance system. The tools the use to give visibility to and prevent pesticide-linked occupational poisoning make those institutions structurally blind to the pathogenic effects of many types of occupational exposure to those products. But we go further, showing that the actors involved are still able to see the flaws in those tools to some degree. To account for this, we retrace the history of a study conducted

3. According to the Union des Industries de la Protection des Plantes (UIPP), 62,700 tons of pesticides were used in France in 2011, representing on average 5 kg of pesticides and active substances per hectare of arable land.

4. This applies to an epidemiological cohort study (the Agrican cohort) undertaken in 2005 to improve assessment of cancer risk in farming populations, a study funded in part by the Mutualité Sociale Agricole (MSA).

in the early 2000s by a set of actors in the institutions in charge of preventing occupational diseases in the farming sector, a study that brought to light poisoning due to the use of a carcinogenic plant protection product called sodium arsenite in winemaking. The results of their study revealed blind spots in the standard means of identifying and monitoring pesticide poisoning of workers. However, a decade later the incriminated processes have not been changed and the findings or knowledge acquired by the study on sodium arsenite have been continually ignored by the relevant occupational risk prevention organizations. This case therefore attests to the fact that while official arrangements for managing occupational risk in farming can produce knowledge that reveals flaws in actors' own operating modes, they also enable actors to ignore that knowledge.

To account for how this happened, we will be drawing on the findings of a qualitative survey made up of approximately one hundred semi-directive, in-depth interviews (each from between one and a half and four hours long) with the entire range of actors involved in the current controversies around official recognition of pesticide-use-related occupational diseases. The survey was conducted in the framework of a collective research program we are co-running with Giovanni Prete.[5] The present article is based on a series of interviews we conducted at one time or another with the majority of participants in the scientific, political and administrative process that culminated in the banning of sodium arsenite. We have also studied scientific articles and documents from the Mutualité Sociale Agricole (MSA, the farming branch of France's NHI system) and other organizations showing how arsenic and arsenic derivatives were used in winemaking.[6] The article is divided into three parts. We first show how the principles and tools of the system for assessing occupational risk in farming blocked circulation of knowledge about diseases caused by exposure to pesticides. We then describe the study on exposure to sodium arsenite, highlighting the reflexive and critical abilities of system actors when it came to assessing instruments and principles for monitoring exposure to pesticides. Lastly, we show how the rules, division of labor and risk management tools used encouraged other actors to disregard such criticisms. In the conclusion we demonstrate that the ignorance in question was "organized" in that it is deeply embedded in the structures of the risk management system: all of those structures amount to ways of "domesticating" the critical faculties of system members.

Invisible poisoning

There is much controversy and scientific uncertainty about whether workers exposed to pesticides are thereby exposed to particular diseases. Among active plant protection substances that have been approved for marketing are dozens of molecules classified as "Carcinogenic, Mutagenic or toxic to Reproduction" (CMR.) While the most harmful have been taken off the market, it is perfectly reasonable to assume that those substances have already caused chronic diseases with latency periods that may extend to several decades. Moreover, a considerable number of

5. Giovanni Prete is a member of the IRIS research group, Université de Paris 13.

6. It should be specified that the section of our study on the history of the sodium arsenite ban is not based on interviews with final product users. No institutions representing farmers (either independent ones or farmworkers) took part in the ban process studied here.

"substances of very high concern because of possible CMR effects" are still for sale. However, the common assumption is that farmers are protected from poisoning by an arsenal of measures and norms, one that has gradually been strengthened over the last half century. We show here that at both the national and local levels in France, the rules, principles and tools used in the official system for monitoring pesticide-induced occupational risk foster and maintain ignorance of the effects such products have on the bodies of agricultural workers.

An organizational system for managing and preventing occupational risk among pesticide-exposed farmworkers can be identified in France, even though it has no legal existence. That system consists of a heterogeneous grouping of organizations and tools that came into existence over a long period of time, from World War II to the late 1990s. It is made up primarily of the MSA (Mutualité Sociale Agricole, the farming-sector branch of the national health and social security system), the Ministry of Agriculture, and a commission in charge of assessing pesticide-related health and environmental risks that is now part of the Agence Nationale de Sécurité Sanitaire de l'Alimentation, de l'Environnement et du Travail or ANSES [national agency for food, environmental and worker health and safety] after long being overseen by the Ministry of Agriculture. Governance of chemical and occupational risk in agriculture involves three key regulatory and operational activities: determining the effects of toxins on workers' health and calculating an "acceptable" exposure threshold; recommending rules for toxic substance use that will keep workers below that threshold; and post-product approval monitoring of poisoning cases in order to further define plant protection product use regulations. These activities all fit into a "controlled use" pesticides policy[7] (Décosse, 2013) in which, though the substances in question are recognized to be potential threats to workers' health, operators are understood to be able to manage the risks involved if they take into account the threshold values and use the prescribed safety equipment. It is on the basis of this assumption, and scientific instrumentation of it, that ignorance about links between pesticides and workers' health is in part produced.

Agricultural pesticides: controlled but little-known toxic substances

Before pesticides can be sold they have to be officially approved through a process focused on effectiveness and demonstrations that they are not harmful to human health or the environment. The risks associated with active substances and agents are assessed at the European Union level in accordance with criteria that have been gradually harmonized through a series of directives; specifically, 91/414/EEC, passed in 1991, and regulation 1107/2009, passed in 2009. The relevant EU authority at the present time is the European Food Safety Authority (EFSA). Risks inherent in commercial products containing those substances, on the other hand, are assessed by member states themselves, who decide whether a given product can be sold in that country. In France, the Ministry of Agriculture was in charge of assessing and managing product risks until 2005. Since then the task has been

7. The term assumes a polemical cast here because it so strongly evokes the way the asbestos problem was handled in France from 1970 to 1990. Nonetheless, it clearly expresses a prevention option in which, though the hazard is acknowledged, it is also thought to be acceptable because of all the arrangements that supposedly protect exposed workers: limit values, protective equipment, etc.

performed not by an internal ministerial commission but rather by an independent administration—currently ANSES. ANSES transmits its conclusions on pesticide hazards to the ministry, which then uses them to determine whether or not to approve marketing the pesticide.[8] Plant protection product approval must be renewed every ten years through a new evaluation process. At both the EU and national levels, risk assessment procedures include an industrial hygiene component where the aim is to define conditions for safe occupational use of the substance or product. This classically involves assessing *danger* and *exposure*,[9] i.e.—in theory—learning about the occupational risks involved and determining effective ways to control them.

While the knowledge produced during risk assessment procedures does allow actors to identify and measure the adverse effects of pesticides on a population of exposed workers, it is nonetheless limited by the fact that assessments are predictive. The models used to measure pesticide harmfulness and exposure are simplifications that only partially account for interactions between these substances and farmers' bodies. The flaws inherent in the measuring instruments used in these assessments have already been pointed out (Nash, 2004; Jouzel and Dedieu, 2013). Harmfulness is measured essentially through in vivo toxicity tests on laboratory animals, a method that identifies acute and sub-acute effects of sporadic exposure to relatively high doses of a single, isolated pesticide. It is therefore not very useful in identifying chronic effects of repeated, long-term exposure to low doses of a variety of plant protection substances—the kind of exposure that occurs in routine agricultural work (irrigation, pruning, harvesting, etc.) in pesticide-sprayed fields. "Acceptable operator exposure level" (AOEL) calculations for workers are aimed primarily at avoiding the adverse effects that occur when farmers handle the product directly or re-enter pesticide-treated fields too soon after application; they therefore tell us little about the effects of more diffuse, less concentrated exposure.

Little attention has been paid to the problems inherent in measuring workers' exposure using this kind of pesticide risk assessment. Measurements are based primarily on models[10] that use data from field studies most of which are conducted by industrial companies. Those data can hardly be said to cover all exposure situations, and they have been extrapolated for all crops on which the product up for marketing approval may be used. Furthermore, the models quantify the protection ensured by a variety of equipment (gloves, masks, suits) by assigning them coefficients. This is done using hypotheses on how the product penetrates the organism of exposed workers. In practice, however, only skin penetration and, in second position, lung penetration, are taken into account. Digestive tract penetration, understood to result from severe worker negligence (e.g., eating or smoking in areas where the product is being used) or else deliberate swallowing (as in suicide attempts using pesticides), is not included. An industrial company applying for product marketing approval has to use these models to demonstrate that *in normal use conditions* and with the assistance of protective equipment if necessary, worker exposure levels will be lower than the acceptable one. It is up to the risk assessment commission to validate these

8. The 2014 law for the future of agriculture, food and forests transfers responsibility for plant protection products from that marketing approval body to ANSES.

9. On risk assessment procedures and their history, see Boudia (2014).

10. The models were first used in Britain (UK Predictive Operator Exposure Model or POEM) and the German Federal Republic (BBA model) and are currently being harmonized at the EU level by the EFSA.

calculations and to the Ministry of Agriculture[11] to approve or refuse to authorize sale of the given pesticide in France. The models induce actors to attribute a crucial role to personal protection equipment (PPE) in occupational pesticide poisoning prevention—a problematic choice in light of a series of recent ergonomics and epidemiology studies (Garrigou, Baldi and Dubuc, 2008; Baldi et al., 2012) that point up the ineffectiveness of some of the equipment recommended on certified product labels. But because its conclusions are based on predictive assessment of pesticide-induced occupational risks, the commission is not likely to take into account empirical ergonomic data. It concentrates instead on defining acceptable exposure levels and formulating rules for use—particularly what equipment should be worn—that will ensure that operator exposure remains below those levels.

Poisoned bodies that remain invisible to prevention institutions

The official understanding that occupational pesticide poisoning can be controlled by setting maximum exposure levels and explaining to farmers how to use pesticides and what protective equipment to wear influences post-product approval action by local implementers of occupational health policies. Most of them belong to the MSA, an organization of central importance in this article. The MSA was established in 1952. It is a private organization, run jointly by representatives elected by three "colleges": independent farmers, agricultural sector employers, and employees. The MSA runs the farming branch of the national health insurance and social security system. Its tasks therefore include prevention and compensation for occupational diseases in this sector.[12] An occupational health service of physicians specialized in farm work and prevention councilors are in charge of prevention. Since 1973, the MSA's 230 prevention councilors have also been in charge of assessing occupational risk in farms that request it and organizing farmworker training. The 380 occupational physicians, meanwhile, monitor farmworkers' health and screen them for occupational diseases during compulsory medical visits. One-third of their time is officially devoted to prevention tasks. Compensation entitlements are determined on an application basis by approximately 200 medical officers (farmworkers have been eligible for compensation since 1955; independent farmers since 2002). All these actors operate out of local MSA offices and contact centers spread throughout mainland France.

Until relatively recently, they were only marginally attentive to pesticide-related health problems (Jas, 2010). It was not until the late 1990s that the MSA began recognizing disorders caused by pesticides as occupational diseases. Few Ministry of Agriculture farm work disease tables mentioned disorders of the sort, and most were benign and involved little in the way of compensation.[13] And as far as prevention was

11. According to the implementation schedule for the 2014 law for the future of agriculture, food and forests, all of these tasks are to be carried out by ANSES from summer 2015.

12. The MSA is also in charge of paying out retirement pensions, family and other welfare allocations and health care reimbursements.

13. Of the first 14 farming-related occupational disease tables established in 1955, only two included dangerous pesticides. This situation was slow to change. Only in 1986 was the occupational origin of cancers caused by arsenic and arsenic derivatives recognized (Table 10), despite the fact that the Ministry of Agriculture had prohibited these substances as carcinogenic in the early 1970s. The Ministry and the MSA have recently reexamined the issue of recognizing pesticide-related occupational disorders: in 2012 the Commission Supérieure des Maladies Professionnelles (COSMAP, higher commission on occupational disorders) recognized that Parkinson's disease can be induced by pesticides.

concerned, the MSA position was that the product marketing approval procedure effectively protected pesticide-exposed workers.

In the 1980s, however, the MSA did put the issue of pesticide-related occupational poisoning on its agenda. In 1991, it set up a poisoning surveillance network that by 1997 covered all of mainland France. That network brings together MSA occupational physicians and prevention councilors whose task is to report all intoxication cases they learn of through farmers or farmworkers to toxicologists who then determine whether or not the pathology can be imputed to the product used. Whenever an intoxication case is reported, the affected farmer or farmworker receives a visit from an occupational physician and/or prevention councilor. The point is to determine what caused the poisoning. The physician or councilor may also observe that the instructions and recommendations for use on the particular product are insufficient. Today, this network is the only form of regular post-product-approval monitoring of pesticide-related occupational risk in France. One of its functions is to send up information "from the field" to the commission in charge of predictive risk assessment in connection with product marketing approval.

However, the network captures few poisoning cases. An average of 200 are reported annually[14]—few, given the extent of the surfaces to which pesticides are applied, the number of exposed farmworkers,[15] and an MSA survey questionnaire showing that one in five farmworkers experience pesticide-related physical disorders every year (Dupupet et al., 2007). There are several reasons for the underreporting. It is partially explained by farmers' attitudes of "denial" or "defiance" (Nicourt and Girault, 2009) toward contamination incidents; such incidents seem inevitable to them given the technical and economic constraints they are working under. Moreover, the network's knowledge infrastructure is also a source of underreporting. Network toxicologists and councilors, MSA occupational physicians and prevention councilors all tend to consider occupational poisoning as occasional overexposure generally imputable to operator error, "bad practices" where the worker has not followed the recommendations on the product label; i.e., failure to wear the recommended PPE, poor hygiene, spraying or otherwise applying in strong wind, overuse, etc. Aware of this general interpretation, farmers who experience physical problems during plant protection product use are unlikely to report them to the competent medical authorities for fear of being symbolically sanctioned by MSA prevention professionals (Jouzel and Dedieu, 2013).

At the central and local levels, then, the organization of occupational risk prevention in this sector fosters exposed worker ignorance of how the pesticides they use may affect their bodies, an ignorance that appears systemic, linked as it is to the organization's dependence on knowledge that is based on the assumption that pesticide poisoning amounts to occasional exposure to high doses of single products and therefore results from accidents that occur during product use. And that ignorance cannot, it seems, be reduced to any ill will on the part of organization

14. During its first ten years of national-scale operation, the pesticide exposure surveillance network collected 1,909 cases; 1554 were confirmed to have resulted from pesticide exposure and recorded in a database.

15. As specified by the INRA and CEMAGREF expert report (Aubertot et al., 2005: 9), there are no truly reliable data on the number of exposed farmworkers. However, according to farmer and farmworker census counts for 2010, France has 604,000 farms and more than a million persons work on them.

actors. Whether they like it or not, those actors are constrained by their work tools to ignore the reality of pesticide-related occupational poisoning. And yet they are not passive. They enjoy considerable autonomy within their organization, and this in turn means they are able to perceive the flaws or limitations of the tools that organization relies on to monitor poisoning of pesticide-exposed workers and to propose ways of correcting those problems and improving tool performance. At least that is what is suggested by the findings of a study conducted fifteen years ago by the MSA fund of the Hérault *département*, which identified an unexpected manner of contamination among vineyard workers exposed to sodium arsenite.

Tracking sodium arsenite: official production of uncomfortable knowledge

The MSA is a decentralized organization made up of a network of local offices or funds and headed by a central fund. The central fund initiates prevention programs for farmworkers, but the programs themselves are defined in large part at the local fund level. The high degree of local independence is justified by the need to act as close to the field as possible and to ensure prevention effectiveness by taking local farming production specificities into account. Prevention professionals working in the funds are also highly independent: farming-sector occupational physicians and risk prevention councilors have a great deal of latitude in defining occupational risk prevention priorities. Some local initiatives targeted pesticide-related poisoning even before the central fund put it on the institution's agenda. This was the case in the Hérault *département*, where a series of initiatives by individual prevention professionals laid the foundation for a real investigation into how farmworkers get contaminated by pesticides. Their study of sodium arsenite exposure, focused on winemakers' actual work and exposure conditions, attests to the ability of farming-sector risk prevention organization members to use their reflexivity and critical faculties to become aware of the flaws and limitations of their risk assessment tools. From their observations, which revealed considerable discrepancies between predictive risk assessment and the realities of exposure, a series of "uncomfortable" conclusions were drawn about official modes for assessing occupational pesticide exposure.

Investigating unexplained poisoning cases

Winemaking is the main agricultural activity in the Hérault,[16] and this sector heavily uses plant protection products.[17] Some are particularly harmful to human health. One such is sodium arsenite, a fungicide used to combat *esca* or grape disease, which attacks grapevine trunks. Whereas all arsenic compound pesticides were banned by the Ministry of Agriculture in 1971 as too dangerous for human health, an exception was made for sodium arsenite in vineyard work because there was no effective substitute product. The idea in risk prevention institutions at the time was

16. In 2010, winemaking was the main activity of 80% of farms in the Hérault *département* and represented over 10,000 full time jobs there (Agreste, 2011 data).

17. Winemaking accounts for 3% of France's farmed surface area and nearly 20% of pesticide use; the most widely used products are fungicides.

that worker exposure to sodium arsenite was so moderate that no damage was done. An MSA biometric sample study conducted in Bordeaux-region vineyards supported this: workers only sprayed for a few days in winter; exposure times were considered too brief to allow sodium arsenite to accumulate in the body; the contamination levels found were low. The fact that the International Agency for Research on Cancer (IARC) had classified the agent carcinogenic in 1987 had not brought about any changes in official risk management options in France.

In the late 1990s, Gilles Bernard,[18] an occupational physician in the Béziers sector of the Hérault, expressed concern about what he perceived to be an increase in vineyard worker poisoning in connection with sodium arsenite application. He had learned of some poisoning cases during routine medical visits to farmworkers; they complained of what he considered worrying symptoms: digestive problems, itching, tingling and prickling sensations, etc. But most reports came to him outside his professional activity. As he himself is a winemaker, he was in regular contact with both farmers and farmworkers, and thereby came to learn of cases of workers who did not dare report their cases to the prevention authorities. The accounts converged: everyone concerned explained that their disorders had come about after using sodium arsenite. The physician's social proximity to the winemaking milieu enabled him to circumvent farmworkers' reluctance to speak about ills that might be associated with exposure to chemical agents. Moreover, Dr Bernard noted that several of the reports concerned employees in companies specialized in pesticide application. In the 1980s and 1990s, economic changes in the Hérault vineyards had led winemakers to turn more readily than in the past to this specialized workforce. The number of holdings had fallen, and average lot size had risen, meaning that winemakers could realize considerable economies of scale by outsourcing pesticide application. The result was a new profile of sodium arsenite exposure,[19] one that had not been considered when the product was reauthorized for marketing in 1971 or during the 1982 MSA study of Bordeaux vineyard work.

In 1999 Gilles Bernard decided to study vineyard worker poisoning caused by exposure to sodium arsenite. To do so he requested and obtained support from the MSA central fund, which sent him a doctoral student in medicine to collect urine samples from exposed workers. The study was of four groups of approximately 15 individuals, each with a particular exposure profile: employees of specialized companies who were exposed over several weeks; workers—farmers and farmworkers—who occasionally treated their own grapevine trunks; workers who had performed tasks in the vineyards in the two weeks following pesticide application, and a control group not likely to have been exposed but living near the study population. The urine samples brought to light cases of severe contamination among workers in the first two groups (Grillet et al., 2004). These findings were an alert: they indicated the presence of a carcinogenic agent in the bodies of farmworkers, particularly pesticide application company employees exposed over long periods. The MSA's pesticide poisoning surveillance network, which received reports of approximately 15 cases of sodium arsenite poisoning during its first two years of national-scale operation (1997 and 1998), provided a concordant, if not as alarming, account. The alert went hand in hand with a mystery. Specialized employees were assumed to be particularly well

18. All respondent names have been changed.

19. Here the annual exposure period came to nearly two months, as opposed to a few days for winemakers treating their own vineyards.

protected against the pesticides they handle: they receive training and are equipped with PPE and tractors aimed to guarantee their safety. The results of this first study suggested that the recommended "good agricultural practices" determined when the product was approved for marketing did not constitute effective protection.

To solve the mystery, Gilles Bernard set out to develop an observation method that would enable him to understand how vineyard workers were contaminated when working with sodium arsenite. In this connection he consulted Jules Vernon, head of the Hérault MSA fund prevention service, a trained ergonomist long interested in the issue and circumstances of pesticide poisoning. In the late 1990s Vernon had developed a "pesticide self-diagnosis" tool to help raise farmers' awareness of contamination sources during the pesticide-application process. Together, the physician and prevention specialist designed a tool for observing sodium arsenite contamination, a sequencing tool with which to note throughout the workday every movement likely to bring about contact between the product and the farmer's body.[20] The MSA central fund helped them recruit assistants in local offices throughout France's winemaking *départements* (Aude, Charente, Gard, Hérault, Indre-et-Loire, Lot, Maine-et-Loire, Pyrénées-Orientales, Rhône and Tarn) who then observed 35 workers throughout the days they spent treating grapevine trunks for *esca* and took urine samples to capture possible arsenite contamination cases and identify how they occurred. The findings were written up in 2001 in a paper that qualified the author for a degree in rural medicine (Durand, 2001).

The biometric component—i.e., the urine samples—demonstrated once again a clear correlation between exposure and contamination levels. The ergonomic component facilitated understanding of contamination circumstances and led to three rather surprising conclusions. First, contamination was most likely to occur not through direct contact of workers with the substance (i.e., during preparation of the mixture and possible contact during application) but rather in mixed, transition areas when workers moved from a "contaminated" area (e.g., containing the application device) to a "clean" one (the tractor cab just before application activity). Such transition areas proved likely spots for a chain of accidents to occur. For example, after mixing the product with water, the worker takes off his gloves, which have been contaminated with the substance, and in so doing contaminates his hands, protection equipment and working equipment (tractor, sprayer, etc.). Second, the very fact that there are several contaminated spots means that contact between workers' contaminated hands and their mouths during food or cigarette breaks (especially if they do not wash their hands beforehand) or through unconscious movements made in the normal course of activity is inevitable. Lastly—and this third conclusion follows from the first two—even employees who had followed the safety instructions and were wearing their PPE got poisoned. Even the best-trained and protected workers—specialized company employees—could not avoid contamination.

Official production of uncomfortable knowledge

The innovative approach used for the sodium arsenite contamination study generated a set of "awkward" data (Heimer, 2012) that could not be taken into account in any straightforward way because it would be a source of social disorganization.

20. For a more detailed analysis of this observation method and the social conditions making it possible, see Dedieu and Jouzel (2015).

Following Steve Rayner (2012), we can describe this information as "uncomfortable knowledge" for the institutions that produce and receive it. According to Rayner, such knowledge threatens the "clumsy solutions" institutions devise for "wicked problems." Our case of occupational pesticide poisoning monitoring suggests the relevance of broadening this definition, as it involves compromises that have become fully routinized. Produced as it was over a long institutional history, the above-detailed official monitoring method continues to seem effective to the actors in charge of it despite the fact that the uncomfortable knowledge generated by the sodium arsenite study calls into question firmly established institutional rules and agreements of seemingly unobjectionable legitimacy. The study findings brought to light three flaws in standard pesticide poisoning prevention and risk assessment methods. First, the error of failing to take into account digestive penetration in assessing risks to workers. Because it objectified contamination cases—cases that are particularly worrying because they involve a carcinogenic agent—the study called into question the overall value of predictive assessment of pesticide-related occupational safety risks, and suggested that substances that appear to be under control as far as the public authorities are concerned may very well not be. Second, by making the discrepancy between risk assessment models and the reality of farmworker poisoning apparent, the study attested to the need for more rigorous post-product approval monitoring. Last, the study showed that prevention institutions are wrong to put their trust in PPE. In sum, the fact that the study was approved and funded by the MSA shows that the institution is capable of taking a critical view of the tools it commonly uses to ensure prevention.

The uncomfortable nature of these findings quickly brought the study to the attention of the central level of the organization for the prevention of occupational risk in the farming sector. Even before definitive publication of the results, the Ministry of Agriculture's plant protection product risk assessment commission had been contemplating banning sodium arsenite and having existing stocks destroyed. The Ministry followed this recommendation, issuing an order to that effect on November 8, 2001. Given the absence of alternative chemical agents for combating *esca*, the rapidity of the authorities' response may seem surprising. In fact, the commission and the Ministry really had no choice given the clear carcinogenic nature of sodium arsenite. Allowing the product to remain on the market and in use was untenable, especially since, as the risk evaluation commission realized upon reading the study findings, it had underestimated the carcinogenic effects of the product for over fifteen years. Those effects had been proved in 1987, whereas labels on products containing the substance in France indicated only a "suspicion" of them. The ban could also be imposed so quickly because the industrial companies using the agent in their products had given up on obtaining marketing reapproval for them in 2002. As they saw it, the business value of a product used exclusively in the winemaking "niche" was too low to justify investing in an approval application that was likely to be rejected anyway given the general tightening of restrictions on pesticides.

Organizational domestication of uncomfortable knowledge: how to remain ignorant once you know

The lessons learned from the MSA study extended beyond the ban on sodium arsenite. The organizations in charge of pesticide monitoring wanted to use the study

to improve tools for assessing and managing the occupational dangers caused by such products. A taskforce was created to this effect within the Ministry's pesticide risk assessment commission. However, more than ten years later it has had no notable impact. The pesticide risk assessment models used still follow the assumption that digestive tract penetration is not relevant and that controlled use of pesticides is possible. Post-marketing approval tracking of occupational exposure has hardly changed. This situation is not due to any general shelving of the study or intention to suppress or conceal the uncomfortable knowledge it produced. Rather, despite their awareness of the critical impact of the uncomfortable study findings, occupational poisoning prevention actors have managed to reduce that "discomfort" for themselves and the organizations they belong to. This process, which we are calling domestication of uncomfortable knowledge, is explained by the regulatory and organizational architecture of arrangements for managing and preventing occupational risk in the farming sector in France. The task specialization, rules, tools and professions involved in this inter-organizational system provide actors with plenty of resources and "good reasons" for discounting or simply not heeding the uncomfortable knowledge in question. Three mechanisms are involved in the domestication process: a *weakening* of the inter-professional and therefore "interdisciplinary" research perspective that made the study possible (it was the fruit of collaboration between a physician and a prevention specialist); *displacement* of the study's uncomfortable conclusions through translation of them into terms compatible with the major orientations of the established program for preventing and managing pesticide-related risks; and *fragmentation* of responsibility for post-marketing approval tracking of occupational poisoning, a situation that creates and maintains the illusion that existing arrangements for surveillance of the pathogenic effects of pesticides on workers' health are effective.

Weakening: the impossibility of reproducing an interdisciplinary study

The story of the sodium arsenite study shows that combining disciplinary perspectives and methods for observing pesticide-induced occupational poisoning can bring to light what remains in the dark when the problem is studied from a single, dominant perspective. However, this unprecedented, extremely productive interdisciplinary undertaking was reiterated only once by the MSA, in a study study conducted in 2002 and 2003 on winemakers' exposure to a set of fungicides called dithiocarbamates. That study observed 56 subjects using the same biometric tool—urine sample collection—designed for the sodium arsenite study. It showed that wearing a mask improved protection whereas wearing gloves did not. However, those results could in no way be seen to validate the sodium arsenite study findings, as sodium arsenite was sold in liquid form whereas dithiocarbamates are sold as powder, making exposure circumstances virtually incomparable. Because the sodium arsenite study observation protocol was used to measure exposure to pesticides sold in a different form, it has not been possible to reproduce or generalize its findings, a fact that considerably limits their uncomfortable or awkward nature for the organizations in charge of assessing and preventing pesticide-induced risks. In fact, there is no proof that what was observed for workers exposed to sodium arsenite holds for other products.

The way the MSA is organized goes a long way toward explaining why such multidisciplinary projects are extremely difficult to extend or reiterate regardless of

the value of the data they produce. There are two major parts to the explanation. The first is that the system is set up in such as way that occupational physicians and prevention councilors do not usually come in contact with each other. The considerable autonomy each group has for organizing its activity, combined with strong status asymmetries, lead them to work separately. As explained, the occupational physicians spend one-third of their working hours developing specific prevention research projects and actions such as training programs and awareness-raising or information campaigns. And the fact is that they often think of that work as secondary. As they see it, those time-consuming projects draw them away from their primary task of medical surveillance, including hiring-related consultations, work resumption and pre-work resumption examinations, and various surveillance exams.[21] Conversely, prevention councilors are often reluctant to use their budget allowances to develop collaborative work programs with physicians due to the status inequality between the two professional groups. While farming-sector occupational physicians enjoy the protected status of the medical profession, prevention specialists are a fragmented group made up of heterogeneous members who have not all had the same training. In addition to feeling that physicians are likely to think of them as subordinates, prevention councilors fear that the symbolic resources physicians enjoy mean that they alone will benefit from jointly conducted projects:

> There's a dichotomy in the MSA system between physicians and prevention specialists. Doctors have the status while preventers have money but no status. So the one who's got status uses it to get money. [Farmers'] occupational healthcare dues are used to pay for medical visits, so once the medical exams, etc. have been paid for, they [the physicians] don't have much left. In prevention, on the contrary, budgets are hefty, and a doctor who wants to do occupational covets those funds. So there's a war between the doctors, with their occupational physician status, and the preventers, at best office heads and at worst project officers. The MSA is labor inspectors, social workers, etc., all covered by the same labor accords. The doctors, on the other hand, they're rural life and historical status. The farmers say, "Good morning, Doctor"—they're the only ones who get addressed like that. So there's that relationship going on here. (Interview with Jules Vernon, September 2010).

The study that led to the ban on sodium arsenite offers a concrete example of these different obstacles. The first reason the product could be banned was Dr Bernard's concern to neutralize the statutory asymmetry between physicians and prevention specialists, which he did by assuming a "low profile" vis-a-vis the head of the prevention service at his own MSA fund. Second, the ensuing collaboration between Bernard and Vernon was due to a circumstantial convergence of interests: Bernard had to form an alliance with Vernon to obtain the human resources he needed to carry out the kind of study he wanted, while for Vernon that alliance offered an opportunity to publicize the knowledge he had acquired about farmer and farmworker contamination conditions so that his preventer colleagues in other MSA funds could benefit from it. With their alliance in place, the two men were able to convince their colleagues to undertake the study. The operation succeeded largely due to Vernon's energetic efforts to get prevention councilors from other funds on board for the observation and urine samples:

> There was a meeting in Paris … that was crucial. It was run by central fund physicians. … Prevention doctors came in from Lyon, Bordeaux, Nantes, all the big wine-producing regions, Maine-et-Loire … The thing was getting bogged down because not all the

21. See Munoz (2014).

> doctors wanted to do the job because they weren't invested to the same degree as Gilles [Bernard]—far from it—and the preventers didn't support them [the doctors] because they didn't want to be just water-carriers. … At the MSA you've got to convince people, get them on board; people don't just agree. …. I immediately saw that it would be good to reap the fruits of what we'd done … in connection with work. You observe and you even take biological measurements—from work activity to measurements. I told my [preventer] colleagues, "You can't let a thing like this go by." … So since I had a big reputation with my preventer colleagues … I turned things around. … I fought for it, and my friend from Angers [head of the Angers MSA prevention service] endorsed me and supported me and got us rolling and we went with it. (Interview with Jules Vernon, September 2010).

And yet the collaboration between the doctor and the prevention councilor did not survive the study. Vernon was marginalized when it came to publishing the scientific data: his name appeared in fourth place for the first article and totally disappeared from the following articles, all written by MDs. Organizational changes at the MSA over the last decade have nonetheless worked to promote greater interdisciplinarity between the various prevention specialist categories. Following the labor modernization law of January 17, 2002, which instated the principle of multidisciplinarity in occupational health services, rural medicine was merged with prevention counseling at the MSA to create new occupational health services. This change was an opportunity to bring physicians and preventers closer together. But it also had some unsought effects: most of the heads of the new, composite services are physicians and some prevention councilors now feel they are being overseen by doctors. Furthermore, the merger led Vernon to leave the MSA because he could not find a position that suited him in the new system.

The second obstacle to lasting multidisciplinary collaboration at the MSA has to do with the organization's structural dependence on the farming profession. Like the 35 local funds, the central fund is headed by an administrative council made up of 29 elected members, 27 of whom represent the three branches of the farming profession in France: employees, independent farmers and employers. This type of representation ensures that farm owners dominate because they are represented as both independent farmers and employers. The power of the FNSEA (National federation of farmers' associations), the representative organization to which the vast majority of farm owners belong, reinforces this position; [22] employee unionization, meanwhile, is weak and fragmentary.[23] This governance mode makes it difficult to conduct regular pesticide exposure studies at the MSA because they might end up depriving the profession of plant protection products deemed indispensable for high crop yields. While the power of professional farmers in the MSA does not hinder projects that prevention specialists may wish to implement—once again, they continue to enjoy considerable autonomy—it does limit the scope of those projects. So when sodium arsenite was banned—a decision that the winemaking profession judged harmful to its interests—the Hérault Fund refused to participate in an epidemiological study on links between pesticides and farmworker health funded in part by the central fund.

22. At the last MSA delegate elections, held in 2010, nearly half of the delegates elected by the "independent farmer" college were FNSEA members.

23. In the same elections, the CFDT (Confédération Française Démocratique du Travail, commonly seen as a moderate union) obtained 35% of the votes, while the CGT (Confédération Générale du Travail, leftwing union) obtained 21% and the CGC (Confédération Générale des Cadres; employers) 19%. Abstention in the "employees" college was 71%, compared to 55% in the "independent farmers" and "employers" colleges.

Displacement: ambiguous interpretation of study data

Another factor that worked to marginalize the sodium arsenite study data in occupational health offices was that specialists sought to interpret them in accordance with the prevention principles already structuring their official tasks. The "controlled use" policy on which pesticide-related risk-management operations are based is in turn based on the understanding that plant protection products are intrinsically dangerous but that as long as farmers follow product labels instruction (determined during the marketing approval process) they can use them safely. MSA information campaigns and prevention training are of course designed to improve the chances of safe use. This means that the sodium arsenite study findings could only be understood in terms of a resolutely prevention-oriented approach centered on regulations, official tasks, and the professions of the specialists who constitute the system. The actors did not bother to think about the systemic, inevitable nature of poisoning revealed by the study, arguing instead—and it is here that the ambiguity arises—that the problem could be solved by improving instructions and recommendations for use. The uncomfortable data from the study were therefore displaced or subsumed under ordinary controlled pesticide use principles.

It is true that the actors who participated in the study, namely the occupational physician whose idea it was in the first place, were conscious of the uncomfortable nature of the study findings and the flaws they revealed in the system for protecting pesticide-exposed workers. They recognized the flaws in their prevention tools, which, once again, were based on the assumption that all workers had to do was wear the proper PPE when working with pesticides:

> Basically, you reach the conclusion that even if you explain to farmers how to use the products, it's so complicated they won't be able to do it. So you're deluding yourself if you think the solution is training them and getting them to wear PPE—that's just a regulation alibi. … Instructions are made to be overlooked, misused. (Interview with Dr Bernard, April 2009)

And yet the actors relativized the critical impact of the sodium arsenite study findings. Specifically, they filtered the results through a "functional" perspective (Dodier, 1994) for improving existing systems, thereby limiting their own ability to take into account what they learned about pesticide poisoning. MSA doctors and prevention specialists alike, together with risk assessment experts, have made a point of interpreting the data demonstrating poisoning inevitability in such a way as to make them consistent with the controlled use principle. Acknowledging that pesticide contamination is caused by hand-to-mouth contact and the vicissitudes of everyday work activity would mean acknowledging that it cannot be controlled—a notion that is virtually inconceivable for actors whose primary professional task is risk prevention. Because the study findings were too "abrasive" to fit into a functional perspective centered on improving existing arrangements, they have simply been set aside.

The occupational physicians who participated in the study claim that controlled pesticide use is still possible but that control modes have to be revised. In the conclusion of the medical research paper produced during the second phase of the study, the authors sought to redefine effective prevention, explaining that it would be advisable always to have two persons applying pesticides so as to limit contact between "clean zones" and "contaminated ones." The doctor who wrote up the report made the following admission: "The idea of protection for each zone exists but is

virtually impossible in practice" (Durand, 2001: 71). Nonetheless, he aligned his conclusions with the controlled use position. Following the ban on sodium arsenite, Dr Bernard himself, with the support of the MSA, created an original training program called Phyto-théâtre (Plant protection product theater), in which situations where workers were likely to get contaminated such as those observed in the study are staged and acted out. The aim is give farmers a direct image of circumstances in which they are likely to get contaminated and work organization modes that will reduce if not eliminate that possibility:[24]

> Staging work situations like we do in my Phyto-théâtre makes the individual operator aware that [the work] isn't so easy, that he's got things to do, and that the best solution for managing his problem is not to try to do [the work] better but to find a few ways to make sure that incidents don't happen. Plant protection product companies have started using Phyto-théâtre because they understand the main point: farmers have got to be trained. (Interview with Dr Bernard, April 2009)

The fact that Dr Bernard had firm roots in local winemaking, a world characterized by strong reluctance to discuss pesticide-related health problems, only strengthened his concern to promote this type of preventive and somewhat demanding solution for winemakers. It will be noted that there are two aspects to relations between MSA specialists and the farming world that come into play in recognizing pesticide-related dangers: first, those relations make it possible to identify the "real" ways operators come to be poisoned—realities that official assessment models do not take into account—but second, they lead to relativizing the critical impact of research revealing discrepancies between those official models and reality. Uncomfortable knowledge has thus been displaced[25] to make it fit with controlled use principles in response to "position" effects caused by organizational functions and "disposition" effects involving actors' social embedding (Boudon, 1986).

Likewise, members of the risk assessment commission have claimed that controlled pesticide use is still possible even while admitting the need for product labeling that will enable operators to organize their own protection more efficiently. This seemed enough to them to justify not including the digestive tract as a possible contamination route in risk evaluation models, despite their awareness of the study data indicating hand-to-mouth contact ingestion of plant protection product substances. Integrating oral contamination and the systemic nature of pesticide poisoning into risk assessment would mean for them acknowledging that risks have to be assessed in terms of real types of exposure even when they blatantly undermine the use recommendations that are part and parcel of marketing approval decisions. Because reorienting marketing approval criteria could lead to massive pesticide bans, commission members are in favor of maintaining the existing exposure assessment models:

24. However, an overall change may be observed in MSA prevention messages. They increasingly stress organization modes (stocking products in a "plant protection product base" or defining areas to be used for mixing and cleaning) rather than wearing PPE.

25. We are using the term displacement differently than Rayner (2012). For him the term designates "the process by which an object or activity, such as a computer model, designed to inform management of a real-world phenomenon actually becomes the object of management. Displacement … substitutes a more manageable substitute [for uncomfortable knowledge]" (p. 15). We have used it here in the sense of a rhetorical exercise serving to interpret criticism of a given occupational activity.

> The oral route? No, we don't take that into account. There are strong recommendations not to eat your sandwich and not to smoke while spraying plant protection products, because it's obvious that if you do you'll get contaminated orally. It's a bit problematic: Should we assess the recommended practice or should we assess all practices? If we assess practices that aren't recommended we're going to end up finding product use unacceptable in the vast majority of cases. (Interview with a head of ANSES plant protection preparation risk assessment, January 2011)

MSA prevention specialists and ANSES experts have interpreted the study findings in such as way as to render them consistent with the controlled used principle not primarily because the regulations and principles that frame their tasks and professions dictate a particular manner of thinking but rather because they are trying to show that they themselves are acting in a manner consistent with their function. This quest for consistency is at the core of the uncomfortable knowledge displacement mechanism, and it is characterized by strong ambiguity. While actors continue to defend the controlled use principle, they also acknowledge that it is highly theoretical and quite removed from real practices. Maintaining this ambiguity is therefore a means of resolving the cognitive dissonance (Festinger, Riecken and Schachter, 1956) that arises when actors organizing pesticide control in the workplace use their reflexive capacities.

Fragmentation: how the illusion of efficient pesticide surveillance is maintained

The sodium arsenite study demonstrated that occupational contamination occurs even when the product is used in compliance with the conditions laid down with product sale approval. It therefore brought to light the lack of post-marketing approval monitoring, and it moved the plant protection product risk evaluation commission to take up the problem of how to organize more effective surveillance of occupational poisoning due to use of these products. However, despite the fact that post-approval monitoring of the harmful effects of pesticides has been compulsory since European Union regulation 1107/2009 was passed, little attention is paid in France to the question of pesticide-related occupational poisoning. Recent official reports explicitly point up this problem. A report by the Conseil Général de l'Alimentation, de l'Agriculture et des Espaces Ruraux (CGAAER, General council on food, farming and rural areas) found that only three Ministry of Agriculture and ANSES requests for additional studies after marketing approval in 2010 concerned operator health (CGAAER, 2011: 17).[26] And a Senate information-gathering task-force report entitled *Pesticides: vers le risqué zero* [Pesticides: toward zero risk] (Bonnefoy, 2012: 11) came to a similar conclusion: "Products' real health impacts are not adequately monitored after they have been approved for sale."

The administrative and organizational architecture of the system for managing occupational risk in the farming sector is itself responsible for poor post-approval monitoring. European Union regulation 1107/2009 contains three articles on the matter. The first (Article 31) in effect authorizes France's Ministry of Agriculture

26. The vast majority of requests for complementary studies—127 out of 148—concerned the development of pest resistance to chemical agents. The remaining 21 concerned pesticide impact on biodiversity.

and ANSES to obtain further information from plant protection product companies when approving those products. The other two (Articles 44 and 56) stipulate that reviews of pesticide marketing authorizations are to be based on all available information. Article 56 also specifies that companies must keep the authorities informed on all harmful effects on human health of the products they market. In fact, once the French authorities have approved a product for sale, they demand very little information on pesticide dangers for operators, and companies produce very little such information once their products have been approved.

The authorities in charge of risk assessment and management in connection with marketing approval are reluctant to require pesticide-producing companies to conduct complementary exposure studies, for two reasons. The first has to do with the heavy time pressure they are under. If complementary information is requested, the product can only be approved for three years (instead of the usual ten). And the fact is that postponing definitive marketing approval this way goes against ANSES' priority of accelerating the process so that it will be able to handle the increasing number of applications.[27] More to the point, the experts do not see any use in requesting complementary follow-up studies because to their minds, their own predictive estimations of pesticide effects on farmer health constitute a fully effective methodology. Because theirs is an "ethics of objectification" (Roqueplo, 1997), they conclude that existing data indicating discrepancies between their methodology and reality are not significant enough to justify demands for further information before approving pesticides for marketing. And because it has not been possible to reproduce the interdisciplinary collaboration of the sodium arsenite study and thereby confirm and bolster the findings of that study, risk assessment specialists have difficulty taking those findings fully into account.

Incentives to demand more stringent surveillance of a product once it is on the market are also weak. The main reason is the very existence of the MSA poisoning surveillance network, which all risk assessment and management system actors believe suffices for post-approval monitoring. Moreover, those actors do not consider the data produced by the network as particularly alarming. The 200 cases of occupational poisoning that it reports annually do not seem a high figure, or in any case not high enough to move actors to request companies to produce additional data. This in turn means that the companies have no trouble meeting regulatory requirements on post-approval monitoring of occupational poisoning due to use of their products: they just claim that poisoning cases remain "somewhat theoretical."[28] They are legally justified in assuming that it is up to ANSES and the Ministry of Agriculture to request complementary exposure studies from them during the marketing approval process and to turn to the MSA and its poisoning surveillance network for information on occupational poisoning. Moreover, they claim that they more than meet regulation requirements through their "progressive actions": bringing in academics to design projects for assessing operator exposure during application and the effectiveness of available safety protection equipment.[29]

27. According to the ANSES members we interviewed, applications have increased by 30% in the last four years.

28. Interview with the director-general of the IUPP pesticide producer association, Feb. 2012.

29. In the last several years, the European Crop Protection Association, representing plant protection product manufacturers at the EU level, has set up a Safe Use Initiative that consists primarily of conducting exposure studies in southern European countries, the aim being to assist in designing more effective PPE.

Risk prevention actors' discourse on network efficiency is therefore ambiguous. While recognizing the problem of underreporting, they cite the network's existence as proof that regular post-marketing approval monitoring is in place and that it will eventually take more accurate account of real exposure conditions. The network appears to fulfill this function well because on two occasions it acted to discover exposure information that impacted on pesticide-related occupational risk assessment and management. The first was in connection with the 2001 ban on sodium arsenite (network data supported initial suspicions of vineyard worker poisoning); the second was the introduction in 2006 of a compulsory waiting period before workers can reenter treated fields, a period ranging from a few hours to several days depending on product toxicity[30] (this followed on several network-reported poisoning cases). But network impact goes no further than these changes, primarily because of the afore-cited intrinsic flaws and limitations of this tool. And though the 2001 and 2006 changes indicate that there were defects in the system for protecting pesticide-exposed workers, surveillance actors think that they indicate just the opposite; that is, that the system functions well and can serve to alert the public authorities to unpredicted contamination cases.[31] The shared belief that the poisoning surveillance network functions well conceals that fact that it provides very little long-term monitoring information of the sort that could be used in epidemiological studies of the chronic disorders caused by these products. No such monitoring procedure was put in place after the sodium arsenite study, for example, despite the fact that it had demonstrated that the bodies of observed vineyard workers had indeed been contaminated by this carcinogenic product likely to have long-term effects. For MSA actors, the lack of any change is justified by the fact that they also participate in the *Agrican* epidemiological study of cancer in the farmer population. But as explained, the MSA's Hérault fund, which ran into opposition from the local winemaking profession following the ban on sodium arsenite, refused to participate in that study; it therefore in no way monitors the health of workers who were surveyed for the sodium arsenite study. In sum, the statistical invisibility of the occupational diseases that farmworkers are likely to contract after exposure to pesticides has bolstered the legitimacy of the existing prevention system when in fact that invisibility is partially *due* to the system.

Neither the CGAAER report signaling inadequate post-marketing approval monitoring[32] nor the lessons learned from the sodium arsenite episode have led to any substantial changes in the current system.[33] Very simply, the actors involved see

30. Six hours for outdoor application, 24 hours for irritants, 48 hours for products that can affect the entire organism through skin or respiratory tract contact.

31. This is attested by the CGAAER report, which gives excessive credit to the MSA poisoning surveillance network for the ban on sodium arsenite and draws a reassuring conclusion about it: "Because farmworkers report [to the network] on a voluntary basis, it is hard to assess how representative [its information] is. But it did make possible a variety of prevention and operator protection measures, including withdrawal of sodium arsenite from the market after an exposure study launched in response to disturbing information it had sent up" (CGAAER, 2011: 19).

32. "The current arrangements need to be clarified and considerably reinforced if they are to offer the health and environmental guarantees expected of them" (CGAAER, 2011: 5).

33. France's new law on the future of agriculture, food and forests provides for permanent monitoring of pesticide impact on health and the environment, specifying that ANSES is in charge of this task. However, as we write, the Agency has not allotted any specific funding to perform it.

no need to make any changes because in their opinion the arrangements necessary for regular monitoring of occupational poisoning are already in place. The dilution of responsibility for post-sale approval monitoring bolsters the illusion of control sustained by the existence of the MSA poisoning surveillance network. Because the division of labor at the MSA is such that several actors are responsible for monitoring, it becomes so *fragmented* that it is in fact not really carried out; the actors, meanwhile, feel that the opposite is true. Each feels that he or she is fulfilling their monitoring obligations and each lays the responsibility for requesting or producing possible missing information on someone else. The respective responsibilities of ANSES and the Ministry of Agriculture in this area are very vaguely defined; those administrative bodies rely primarily on data produced by the MSA's poisoning surveillance network when it comes to noting possible pesticide-related workplace health problems. While they acknowledge the weakness of that network, they also claim that it is up to the MSA to strengthen it. The MSA meanwhile recalls that producing this type of data is not one of its official tasks, and that it is up to ANSES and the Ministry of Agriculture to systematize demands for post-approval monitoring during the risk assessment phase, as stated in the European Union regulatory documents cited above. This *fragmentation* mechanism ensures "distributed ignorance" (Heimer, 2012) of poisoning among workers exposed to pesticides, ignorance that provides each system actor with good reasons to believe the system is functioning properly. As in the "structural secret" notion developed by Diane Vaughan (1996) in her study of the American aerospace industry, division of labor within the French system obstructs identification of potential problems. And in our example, whenever there is doubt about system reliability, actors always have the option of imputing the responsibility for protection to operators themselves since there are not enough solid data to demonstrate the fallacy in this reasoning. The belief shared by occupational pesticide use risk assessment and management system actors that existing use rules will ensure operator protection actually does just that: it makes operators responsible for the suffering those substances can cause. Hand-to-mouth contamination is often classified as the result of operator failure to follow basic hygiene rules. With this in mind, all system actors can reassure themselves by recalling that "a correctly used product shouldn't cause any accidents."[34]

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Ignorance of pesticide-related occupational poisoning in France is "organized" in that it is closely tied to the way the occupational risk regulation system in the farming sector is structured. However, the sodium arsenite study example demonstrates that the actors in this system do have some latitude to perceive system limitations and try to correct them. They are able to produce "uncomfortable" information that exposes flaws in the institutions they belong to as well as fragility in work place pesticide monitoring and control. But the very manner in which the system for preventing pesticide-induced occupational disorders is organized in turn works to domesticate that uncomfortable knowledge and to align it with existing, ordinary pesticide control arrangements. It provides system actors with resources for continuing to ignore

34. Interview with the UIPP director-general in the free daily newspaper *20 minutes*, Dec. 12, 2011.

what they have learned by way of epistemic innovations. Because that manner of organization *weakens* the type of actor alliances that produce uncomfortable knowledge, *displaces* the meaning of uncomfortable findings and *fragments* responsibility for occupational poisoning surveillance, it gradually creates compatibility between uncomfortable knowledge and the system's own ordinary orientations. While the system is capable of producing awkward facts, it also impedes reproduction and consolidation of them. To put it another way, the organizational structure provides support for a *hermeneutics* of uncomfortable knowledge. Hermeneutics, a term originally referring to interpretation of sacred texts, here designates the move to interpret awkward information in a way that will make it consistent with the routine rules that structure an organization. In this sense, organizational structures do indeed play the role of "cognitive architect" (Michaud and Thoenig, 2001), affecting the meaning that members attribute to their actions (Weick, 1995). But that cognitive frame is not mechanical, taking instead flexible, complex forms that simultaneously integrate and domesticate actors' reflexive, critical abilities.

Our study therefore makes it possible to get beyond the opposition between intentional and unintentional ignorance production. It seems reasonable to assume that unintentional ignorance is no longer such when uncomfortable knowledge production makes the actors aware of what they did not know. And yet continuing ignorance is not the result of deliberately constructed strategies either. In the case of pesticide-related risk in France, it is instead the product of an organizational and institutional construction process that began more than seventy years ago. The organizational architecture that developed during this long history obliges institutional actors to leave aside certain embarrassing problems in order to show that they are acting consistently with the policy, technical and scientific orientations that frame their official tasks. If we assume that this concern for consistency is what drives ignorance construction, it becomes clear that ignorance has a highly particular function within organized systems: like those systems' formal structures, rules, guiding principles and division of labor, ignorance constitutes a foundation for routine organization.

Can we conclude from this that alerts from members of institutions in charge of controlling health risks are systematically doomed to go unheard? Whatever the answer, our work highlights the ability of such institutions to "live with" alerts that are potentially abrasive to their own action logic. The broader question then becomes, are official risk management systems condemned to undertake institutional change only in the aftermath of crises or scandals? To answer this, we also need to study how risk management organizations domesticate uncomfortable knowledge over the long term: Do they cause that knowledge to disappear or do they preserve traces of it which, combined with other factors, may lead to profound institutional change?

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