Perspective: regulation of pest and disease control strategies and why (many) economists are concerned

Wesseler, J.

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Perspective: regulation of pest and disease control strategies and why (many) economists are concerned

Justus Wesseler*

Abstract

Pests and diseases are a continuous challenge in agriculture production. A wide range of control strategies have been and will continue to be developed. New control strategies are in almost all countries around the world assessed prior to approval for use in farmers' fields. This is rightly so to avoid and even reduce negative effects for human health and the environment. Over the past decades the approval processes have become increasingly politicized resulting in an increase in the direct approval costs and the length in approval time without increasing the safety of the final product. This reduces the development of control strategies and often has negative human health and environmental effects. Possibilities exist for improvements. They include reducing approval costs and approval time by streamlining the approval process and substituting approval requirements by strengthening ex-post liability.

Keywords: approval; economics; pest management strategies; policy; regulation

1 INTRODUCTION

The control of pests and diseases in agriculture is important. Pests and diseases reduce crop yield and crop quality. Pest and disease management strategies include a wide range of options. In the context of this perspective, the focus is on biological and chemical control agents such as microbes and chemicals and pest and disease-resistant plants. Cultivation practices such as crop rotation, land preparation and other similar practices can also play an important role in pest and disease control, but they are not the major focus of this contribution. The management strategies considered are regulated by government policies. Many of the regulatory policies have direct cost effects such as the prior approval of management options increasing the costs of the developer, the restrictions on the scope of management options such as timing and/or quantities of pesticide use increasing the costs of the user; others indirectly *via* labor laws, environmental regulations, nature conservation policies and more. These regulatory policies while increasing costs are also expected to provide additional social benefits justifying the additional costs.[1] These benefits in most cases include potential damage costs avoided.

In recent years a debate about the appropriate level of regulations has emerged driven by the debate about the introduction of genetically modified organisms (GMOs),[2] new plant breeding technologies for pest management,[3] and biological control options.[4] The debate is not only limited to those mentioned, but also applies to other pest and disease management strategies.

Many economists as well as other stakeholders are concerned about the recent regulatory policy developments.[5,6] They have increased the research, approval, and application costs without often providing additional benefits justifying the additional costs. In some cases they have even had negative implications for the environment, industry structure and innovations in pest management strategies.[2] The latter is particularly worrisome as the challenges posed by climate change require innovative solutions for adaptation.

In this contribution the regulations of pest and disease management will be discussed from an economic perspective. The recent developments in the European Union will be addressed and possibilities for improving regulatory policies discussed. This is not only relevant for the case of the European Union but also for other countries such as the United States and those that follow, often for many good reasons, European Union policies.

The contribution is organized as follows: first the economics for regulating pest and disease management will be discussed and based on that, appropriate regulatory approaches will be derived and contrasted with current regulatory policies before providing suggestions for improvements.

2 REGULATING PEST MANAGEMENT

The regulation of pest and disease management can be justified if the additional regulatory costs generate a large enough amount of additional social benefits. Private benefits and costs generated matter at farm level mainly to the farmer. Depending on the local agro-climatic conditions including soils and landscape and the economic environment, farmers will use different pest and disease

* Correspondence to: J Wesseler, Department of Social Sciences, Wageningen University, Hollandseweg 1, 6706KN Wageningen, The Netherlands. E-mail: justus.wesseler@wur.nl

Department of Social Sciences, Wageningen University, Wageningen, The Netherlands

management strategies. Those management strategies will not only differ by crop, but they will also differ by crop and farm.

At farm level the optimal control level is where the marginal private benefits equal the marginal private costs. Regulatory intervention from an economic perspective is justified if additional costs arise that the farmer does not take into consideration and have not yet been priced by current policies.[7] The presence of additional non-private costs does not imply that the use of a pest and disease management strategy should be reduced to zero. The simple reason is that the pest and disease management strategies also generate additional benefits, for example, in the form of higher yields, yield quality and reduced input use or some combination thereof. The observation that a pesticide causes environmental damages does not *per se* justify a ban. The reduction in environmental damages needs to be compared with the additional costs in the form of reduced private and non-priced external benefits to justify a ban or a constraint on use.[1]

That a pest and disease management strategy is used in the first place already tells us that it generates benefits at farm level – why would the farmer otherwise use it? – and hence, policy interventions changing use result in additional costs at farm level.

Modelling the economic benefits of pest and disease management strategies at farm level has to take into consideration that pest and disease management is a damage control strategy.[8] Damage control is not a yield increasing strategy such as, for example, an increase in fertilizer use. This is shown in Figure 1, which is a simplified illustration of the relationship between a damage reducing and a yield increasing input such as fertilizer, holding everything else constant. Damage control reduces the difference between actual and potential yield. This is equivalent to a move from point *a* in Figure 1 closer to point *b′*. Overall, damage control moves the realized yield function closer to the potential yield function. Changes in fertilizer use are a movement along the yield function. The optimal level for fertilizer use, *ceteris paribus*, in Figure 1 is where the marginal product of fertilizer, the slope of the yield function, is equal to the fertilizer price, product-price ratio. In principle, if fertilizer and product are priced according to the opportunity costs principle, the optimal use not only reflects technical, but also allocative efficiency.

The difference between damage reducing and yield increasing inputs has implications for the economic model to be used for identifying the optimal level of damage control. In the case of pest and disease management a production function modelling pest and disease management as a damage control input should be applied where pest and disease management reduces damages, *i.e.* yield losses. Otherwise, the optimal level of pest and disease damage control will be overestimated while modelling pest management as a yield increasing strategy.[8] Further, expenses for pest and disease control are sunk costs. If uncertainty over the success of pest and disease damage control strategies in the form of incomplete knowledge about future pest and disease pressure is added and timing of pest and disease control is flexible, this further reduces optimal intensity of pest control.[9]

The increase in actual yield as a result of successful damage control, often implies that the optimal level of yield increasing inputs such as fertilizer also increases. This is indicated by the difference in fertilizer input between point A and B on the horizontal axis (Fig. 1) and a move from point *b′* to *b* along the potential yield function.[10] This is relevant for cases where additional use of fertilizer might be an obstacle, often observed for many developing countries, where the full economic benefits of pest management might not

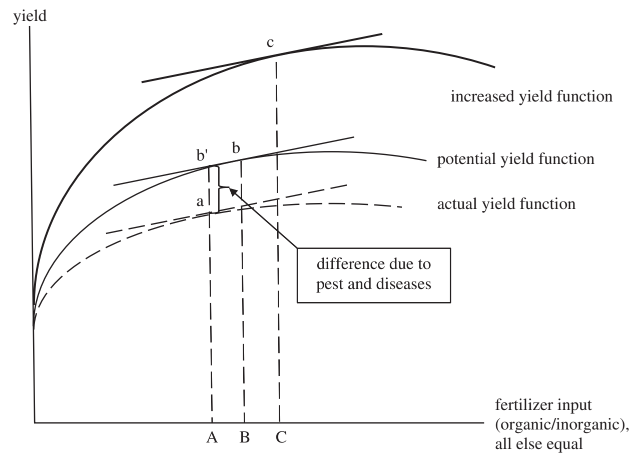

Figure 1. Changes in damage control on yield and optimal fertilizer use. Note: the yield functions show the change in yield with an increase in fertilizer use, related to one fertilizer technology such inorganic nitrogen or organic nitrogen, holding everything else such as soil quality constant. The *potential yield function* illustrates the yield that can be achieved without any damages due to pest and diseases. The *actual yield function* illustrates the yield achieved considering pest and diseases. The *increased yield function* illustrates the effect a 'new variety' using fertilizer more efficiently. The straight lines are the constant fertilizer price/product price ratios. The points *a*, *b*, and *c* show the optimal level of fertilizer use given the price ratio.

be realized, nevertheless a movement from *a* to *b′* can be possible. Further, if new technologies move the potential yield function upwards, for example, nitrogen fixing plants, the economic benefits of pest and disease management increase as the potential losses increase. This illustrated by the difference between point *a* and point *c* in Figure 1. Hence, potential yield increasing technologies increase the demand for pest and disease management or, to put it the other way around, the adoption of potential yield increasing technologies might be limited by the availability of pest and disease management strategies.

While the above is a somewhat simplified synopsis about the link between damage control and yield increasing inputs as in reality increase in the efficiency of fertilizer use and up-take, drought tolerance and more complicate the effects of damage control and fertilizer use on yield. Nevertheless, the major effects sketched, *i.e.* damage control has an effect on the use of other input factors and *vice versa*, still holds.[10]

In summary, a ban or additional constraints on the use of pest and disease management strategies practiced by farmers results in additional costs at farm level and related income losses. This, while widely recognized in the scientific literature,[11] is often not sufficiently considered in policy debates over regulating pest management. The discussion about the ban of broad-spectrum herbicides such as glyphosate serves as a point in case. The debate became highly politicized with accusation about biases in the assessment made by several stakeholders being involved.[12] What has been less considered within the debate is that the use of glyphosate provides several benefits to farmers as well as society. The technology simplifies weed management, highly appreciated by farmers,[13,14] reduces environmental damage in no-till agriculture due to reduced soil erosion and as alternative weed management strategies often rely on herbicides with a higher environmental impact quotient,[15,16] reduces greenhouse gas emission due to less tillage,[15,16] and can reduce herbicide use on the following crop.[16] For sure, there are costs, such as the evolution of glyphosate resistant weeds, requiring more appropriate weed management strategies, however not unique to glyphosate but a general attribute of herbicides,[17] but hardly justifying a ban from an environmental, as well as economic point of view.[18,19]

The case of glyphosate raises the question of how to assess the benefits and costs taking into consideration potential irreversible effects, an argument often raised by groups critical towards the use of glyphosate.[20] One possibility is to assess the benefits and costs under uncertainty and irreversibility by identifying the economic threshold level that should not be passed. This has been called in the literature the *Maximum Incremental Social Tolerable Irreversible Costs*.[21] The threshold level can be used to check if evidence suggests that this threshold level could be passed. An application to the introduction of herbicide resistant sugar beets and maize in the European Union shows that there are substantial doubts that the threshold levels will be reached. For the case of herbicide resistant maize, irreversible costs have to be in the order of approximately 25 million Euro per year in 2005 values for France and for the case of herbicide resistant sugar beets of approximately 163 million Euro per year in 2004 values for the whole EU to justify a delay in approval from an economic perspective.[21,22] Nevertheless, substantial regional differences can exist.[23]

These values also provide an indication about the annual benefits lost by delaying the approval. Considering that those crops have not been introduced but could have been by the mid-2000s shows substantial annual economic benefits foregone. Assessments for major crops at the world level confirms that the delays in approval can be substantial.[24] While one might argue that this does not matter that much for the European Union, a well-developed and wealthy region, this can hardly be argued for, for the case of developing countries.[25] Many more studies show that pest management using transgenic crops generate substantial economic as well as environmental benefits.[26–28] Those are foregone by delays in approvals or bans in countries not adopting the technology in crop production.

3 THE APPROVAL OF PEST MANAGEMENT STRATEGIES

Almost all pest management strategies require approval prior to use. The approval takes time and can be very costly. Time and costs vary by jurisdiction[5,6,29,30] and for the case of the European Union are also highly politicized including transgenic crops,[31] biological control methods[5] or pest management of invasive species.[32] As mentioned above the approval procedures delay access to the technology, resulting in foregone benefits.[25,33]

The approval processes in the European Union for pest and disease control strategies not only includes the risk assessment, done by Member States and the European Food Safety Authority (EFSA), but also the so called risk management phase where expert committees assess and vote on dossiers prepared by the European Commission based on the risk assessment.[5,6] Studies done for the approval of transgenic crops in the EU show the risk management step takes on average 594 days[6] and for microbial biological control agents (MBCAs) on average 278 days.[5] In many other jurisdictions this step is not included in the approval process. Avoiding this step at EU level can already speed-up approval without compromising safety. A reform of the approval process more closely to the one for food under the General Food Law could be one of the possibilities. This would allow moving from maximum harmonization towards minimum harmonization within the European Union and provide more flexibility for member states to approve pest and disease control strategies without compromising on internal markets. A solution recently discussed also for the approval of new plant breeding technologies.[34]

For the case of MBCAs a comparison with the United States shows the overall approval process in the EU takes on average additional 532 days, including the risk management step of 278 days. The remaining difference suggests possibilities for further reducing the length in approval time and related costs exist. Additional possibilities for streamlining the risk assessment as pointed out by lobby organizations and others include a more science-based approach, streamlining the approval process, and providing more flexibility within the approval system.[35–38]

Further, the bias in the risk assessment in the EU, but many other countries as well, by concentrating only on risks and not considering the incremental benefits of a new pest and disease management strategy creates an additional hurdle by either reducing strategies being developed that might otherwise be beneficial, or increasing the research and development costs of applicants to comply with approval requirements. From an economic perspective this generates additional costs that can be enormous, estimates range between 53 000 and 15 million per trait for a transgenic crop, while industry reports much higher numbers.[30,35] Similar costs can be expected for the approval of biological control agents.

The approval process itself is not only costly for the companies involved[30] but has also implications for the market structure of the pest management sector.[39] The approval costs act as a kind of sunk costs discriminating against smaller companies reducing overall competition within the sector by reducing market entry. The approval costs are not only an issue for small and medium sized companies. The recent mergers of Syngenta and China National Chemical Corporation (ChemChina), DOW and Dupont, and Bayer and Monsanto are examples. The mergers are driven by expected synergies reducing research and development as well as operational costs and are better prepared to comply with high approval costs.[39] Ironically, several societal groups calling for high ex-ante regulatory policies are also concerned about industry concentration,[40] while the demand for those ex-ante regulatory policies supports industry concentration.

Many economists have long argued that not only ex-ante regulatory standards are a tool, but also ex-post liability, for addressing safety issues.[41–43] Ex-post liability allows holding developers of a new technology liable for potential damages. This provides incentives for the developer of the technology to act carefully to avoid liability without implementing mandatory ex-ante regulatory standards. Still, it needs to be mentioned that ex-post liability has some shortcomings. The person or the company represented by that person being held liable, might not have a sufficiently large amount of resources available for the damages to be compensated. Companies have been observed to file for bankruptcy for avoiding compensation payments.[43] Also, legal systems are not always equal. Large corporations are often able to hire the best lawyers while the opposite party might not – the deep pocket argument. Further, judges might be biased as well.[43]

Despite the problems using ex-post liability as a regulatory tool, a number of possibilities exist to address these shortcomings as well. They include compensation funds, insurance systems, and improvements in the legal systems. Civil law countries, for example, such as the majority of European Union member states, are less vulnerable to the deep pocket argument in comparison to common law countries such as the United States.[43] Further, many of the potential damages being mentioned related to new pest and disease management strategies are rather hypothetical and often less pronounced in comparison to currently practiced pest and disease management strategies reducing the possibility of ex-post liability.[2] The design of ex-post liability in this case becomes more important.

The use of ex-post liability has not received enough attention in the current debates on the approval of new pest and disease management strategies. Concerns about new pest and disease management strategies are often related to potential risks only. The current debate about genome editing serves as a case.[34] Genome editing as well as many other technologies allows one to address a number of important challenges for pest and disease management. Important examples include zoonotic diseases such as malaria, Zika virus disease, or trypanosomes and invasive species such as the fall armyworm in Africa, citrus greening disease in the United States or the Western Corn Rootworm in Europe. The fall army worm invasion in Africa in 2016 and 2017 serves as a point in case,[44] where, for example, gene driven technologies can provide solutions with less negative implications for the environment in comparison to solutions based on insecticides and herbicides.[45]

A case has been put forward to the Court of Justice of the European Union (CJEU), where the question had been raised whether herbicide resistant plants developed by using modern forms of mutagenesis should be considered GMOs or not according to the Directive 2001/18 EC.[34] The CJEU decided that crops developed by using new plant breeding technologies applying mutagenesis techniques developed after 2001 will be considered GMOs according to the EU definition, will fall under the Directive 2001/18EC and hence be regulated as GMOs according to EU law. The ruling and the following legal acts will be important for the development of new pest and disease management strategies. Depending on the translation of the judgment into legal acts,[46] approval costs will be higher or lower with direct implications for the incentives to invest in new pest and disease management strategies. The ruling will affect a wide range of pest and disease-management strategies including biological control methods. In particular, biological control strategies can benefit from gene editing tools as screening of possible control agents and translation into control strategies can be simplified also to the benefit of organic agriculture.[47] Supporters of using these new technologies, nevertheless, have been heavily criticized.[48]

4 CONCLUSION

The swelling regulation of pest management strategies in the European Union and other parts of the world has increased the costs of agricultural production. In many cases the additional costs are not justified by additional benefits generated. One among other reasons is that the debate has become highly politicized and less based on facts. The increase in costs has negative implications for the development of new pest and disease management strategies. First, the increase in investment costs require a higher level of benefits to justify investment. As a result, less pest and disease management strategies will be developed. Second, the higher investment costs discriminate against smaller companies by making it more difficult to enter the market. As a result, a smaller number of companies will enter the market reducing the number of solutions developed.

A number of possibilities exist to reduce the approval costs. First, the length in approval time can be shortened by streamlining the approval procedures without compromising on safety. In the EU the risk management step at EU level can be dropped and directly delegated to Member States. At international level approval processes can be harmonized to reduce potential frictions in international trade. Once the safety of a new product has been established, for example, it should receive world-wide approval for processing and consumption (where applicable).

Second, approval procedures should not only assess potential risks but also consider potential benefits and thereby increasing the range of possible solutions. The increase in range in possible solutions will also provide opportunities to develop better pest and disease management solutions for a wider range of crops. This will increase crop biodiversity and contribute to make agriculture more resilient to climate change.

Third, regulatory policies should also consider ex-post liability as a regulatory tool to reduce ex-ante approval costs. Many new pest and disease control options have risk profiles not different from already approved control options. Those should be immediately approved and the remaining potential risks covered by ex-post liability. The private sector developing those control options can be asked to develop compensation funds to increase trust in ex-post liability.

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