Sustainable Farming Practices in Europe

Subjects: Others

Contributor: Dmytro Serebrennikov

Modern practices of industrial farming, such as mineral fertilization, caused a widespread degradation of agricultural land and water bodies in Europe. Different farm management strategies exist to reduce the impact of mineral fertilization while preserving soil productivity. The specific focus is on widely adopted and empirically explored measures, such as organic farming, manure treatment technologies and manure fertilization, as well as soil and water conservation methods. Farmers' environmental and economic attitudes in addition to their sources of information have a strong effect on the adoption of organic farming, although there is a lack of evidence of their impact on adopting manure treatment and conservation measures. Similarly, farmers' age and education are found to systemically influence organic farming adoption, but not adoption of other reviewed technologies. While other factors, such as farm physical characteristics or technological attributes, may be important determinants of adoption, it is hard to recognize definite patterns of their impact across technologies given a shortage of empirical evidence.

Keywords: Sustainable Farming ; organic farming ; manure fertilization

1. Introduction

Intensification of agricultural production in the past century across EU countries has seriously undermined the sustainability of the farming sector, resulting in widespread degradation of key environmental resources, such as land and water. One pernicious side effect of intensified farming is a nutrient surplus, which is defined as a positive difference between the amount of nutrients added to the soil (e.g., via fertilization) and the amount of nutrients taken or removed [1]. Despite some recent reductions in fertilizer application, the total inputs of key nutrients, such as nitrogen and phosphorus, still considerably exceed the soil absorption limits [1][2]. Additionally, the efficiency of the application of these nutrients remains extremely low [3]. Due to the high nutrient concentration, part of that surplus may be washed off from soil by heavy rains, causing environmental problems [4]. Another risk arising from high nutrient levels in soil relates to mineralization and an increased loss of organic carbon. It is reported that 45% of European soils experience infertility due to severe carbon deficits [5].

Reducing nutrient surplus to environmentally sustainable levels is crucial for achieving the aims of the Common Agricultural Policy [6]. The long-term effects of controlling soil nutrient levels may include improved agricultural productivity, soil fertility and biodiversity, which are important to ensure the stability of future food supply. The nutrient surplus reduction strategies are based on a combination of measures aimed at the preservation of soil structure and increasing nutrient and water use efficiency [7]. In addition, an important part of optimizing nutrient flows, stocks and emissions is through improved recyclability and reduced waste of animal by-products, such as manure [8].

There is ample evidence of the positive effects of organic farming, manure treatment and manure-based fertilizers and soil and water conservation on agricultural production and soil qualities. For example, conservation measures are shown to increase plant fertilizer uptake [9] and reduce surface water run-off [10], which is crucial to retain nutrients in soil and reduce the need for imported minerals [11]. Similarly, nutrients from recycled manure may substitute for chemically produced analogues [10]. Organic farming is an alternative farm management system combining various conservation measures and manure-based fertilization, while prohibiting application of mineral fertilizers. As a side effect of reduced reliance on chemical fertilizers, farmers may increase their resistance to external economic shocks (e.g., volatility in energy prices).

Previous literature reviews exploring factors of farmers’ adoption of sustainable practices focused primarily on conservation technologies. For example, Knowler and Bradshaw [12] reviewed adoption studies of conservation tillage, crop rotation and cover crops in developing countries and North America, summarizing both the direction and significance of statistical effects of adoption factors. In a similar paper, Wauters and Mathijs [13] performed a meta-analytic review of factors affecting the adoption of conservation measures in the U.S., Canada and Australia. Furthermore, Carlisle [14] narratively reviewed determinants of adoption of various soil health practices in application to agricultural commodity

production in the U.S. We extend these reviews by focusing on recent adoption studies of soil and water conservation in Europe, while also complementing them with a review of factors affecting adoption of organic farming and manure treatment technologies. Adoption of agricultural technologies in Europe might differ from other locations due to specific regulations, customs and natural conditions.

To the best of our knowledge, there are just a few examples of literature reviewing factors of adoption of sustainable farming in Europe. For example, Lahmar et al. [15] provided a general (non-critical) overview of drivers and constraints of conservation agriculture development in such countries as Italy, Spain, France and Czech Republic. Separately, Prager and Posthumus [16] reviewed determinants of adoption of soil conservation measures in several EU countries, using responses to standardized farmer surveys. Liu et al. [17] also mentioned several European studies in their review of factors of farmers' adoption of best management practices aimed at the reduction in non-point source pollution. In the most recent case, Dessart et al. [18] provided a policy-oriented review of behavioral factors influencing the adoption of various sustainable farming practices in Europe, such as organic farming and conservation agriculture. While this paper covers several studies also mentioned in our review, it focuses exclusively on behavioral factors of adoption such as farmer attitudes while disregarding other common determinants of adoption (e.g., farmer demographic attributes). Additionally, it covers studies on adoption of agri-environmental schemes, which is beyond the scope of the given review.

2. Factors Influencing Adoption of Sustainable Farming Practices in Europe

A variety of factors having an impact on the adoption and proliferation of such technologies as organic farming, manure treatment and conservation measures. In general, it is hard to compare the effects of various adoption factors across the three technologies, given the obvious shortage of empirical evidence on manure treatment and conservation farming in the EU. While it is possible to track the effect of selected demographic attributes, like age or education, on organic farming adoption, their impact on the adoption of manure treatment and conservation farming remains rather dubious and inconclusive. Additionally, the impact of household characteristics on the adoption of sustainable agriculture remains largely under-investigated, with just a few studies exploring the effect of household size or that of descendants. With respect to farm structural characteristics, it is shown that farm size might be a strong predictor of adoption of organic farming, with rather scant evidence of its impact on other technological adoptions. Other factors of this group, like distance to urbanized areas, might also influence farmer behavior, as follows from the selected studies covering various technologies. It is worth noting the evidence of the impact of farm financial state on conservation farming, which is absent from the studies on organic farming and manure treatment adoption.

Furthermore, farmer attitudes and beliefs are shown to clearly determine the adoption of organic farming in the EU, with environmental attitude stimulating adoption and economic attitude discouraging it. On the other hand, there is an absence of regular evidence of their impacts on both manure treatment and conservation farming adoption. Specifically, there is only one recent study exploring the impact of farmer attitudes on manure treatment and three other studies that investigate this aspect of adoption in application to conservation agriculture. Apart from attitudes and preferences, farmers may also formulate their adoption strategies under the influence of their sources of information, like media, an advisory service or other farmers. This conclusion follows mostly from the studies on organic farming adoption, although limited evidence exists proving the impact of informational sources on adoption of other technologies too.

Finally, we found no systemic evidence of the impact of technological attributes on organic farming adoption, save for one study showing the positive effect of the market price of organic production. In a similar way, the price of organic fertilizer might be a predictor of adoption of manure fertilization methods, in addition to other physical and chemical characteristics of manure. While conservation farming attributes are mentioned in a few studies, they provide no systemic evidence of a statistically significant impact. Regarding the impact of institutional conditions, it was shown that adoption subsidies may induce the development of organic farming and manure treatment technologies, but this effect is missing for conservation farming adoption.

3. Conclusions

Sustainable management of natural resources is one of the long-term aims of the Common Agricultural Policy, along with improved productivity and a stable supply of affordable food [6]. Given the challenge of attaining these aims, it is essential to maintain an efficient and circular production system based on the principles of increased recyclability of resources and waste minimization [8]. In agriculture, the decades of intensive use led to the degradation of critical resources such as land

and water. Halting and reversing land degradation is crucial for mitigating hunger and achieving sustainable living [19]. Additionally, the efforts of sustainable resource management in agriculture should be focused on the treatment of animal manure to reduce waste and recover valuable nutrients [8].

Nutrient surplus is a common cause of land degradation in Europe, resulting from over-fertilization of soil with basic nutrients. The negative effects of excessive nutrient use include reduction in soil organic matter, stalled land productivity and water pollution. To deploy efficient nutrient reduction strategies, it is important to maintain a complex approach to land management based on the minimization of soil mechanical disturbance and measures improving nutrient cycles. Various conservation measures, such as reduced tillage, are shown to benefit soil and prevent water pollution. Additionally, technologies aiming to increase treatment and reduce waste of animal manure contribute to resource efficiency while reducing the need for mineral fertilizers, which is crucial for the development of alternative farm management systems like organic farming.

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