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Review

Social Science Studies on European and African Agriculture Compared: Bringing Together Different Strands of Academic Debate on GM Crops

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Abstract: This study explored the social science-orientated literature on genetically modified (GM) crops in Europe and compared it with the corresponding literature on GM crops in African contexts, in order to determine the nature and extent of north-south cross-fertilisation in the literature. A total of 1625 papers on GM crops and agriculture falling within the 'social science and humanities' subject area in the Scopus abstract and citation database of peer-reviewed literature were analysed for major trends relating to geographical areas. More detailed analysis was performed on papers discussing African (56 papers) and European (127 papers) contexts. The analysis revealed that studies on policy and politics were common in both strands of the literature, frequently focusing on effects of the relatively restrictive European Union regulations on GM crops. There were also clear differences, however. For example, papers focusing on Africa frequently examined farm-level impacts and production, while this theme was almost non-existent in the Europe literature. It focused instead on policy impacts on trade and consumer attitudes to GM products. The lack of farm-level studies and of empirical studies in general in the European literature indicates a need for empirical research on GM crops in European farming. Social science research on GM crop production in Europe could draw lessons from the African literature.

Keywords: GMO; biotechnology; agriculture; Europe; Africa; social science

1. Introduction

For the past 15 years there has been an on-going debate in academia and in society at large about the role of genetically modified (GM) crops in food production. A significant section of this debate has focused on potential benefits of GM crops for farmers in the Global South [1–3], with Africa receiving particular attention at an early stage [4,5]. Many argue that as Africa missed the first Green Revolution, it is in particular need of a new Green Revolution where GM technology helps increase crop yields and reduce environmental impacts [5,6].

Significant criticism of this perspective has emerged, in particular within research in the social sciences. Researchers have questioned the relationship between GM crops, production levels and poverty [7,8] and have shown that GM crop development and regulation favours large-scale, capital-intensive farmers, further marginalising small producers [9,10]. Some have also claimed that the GM crops currently available on the market are developed for simplifying large-scale farming practices and are less suitable for resource-constrained smallholder practices [2]. The pro-GM literature and the emerging critique direct a significant amount of attention to the Global South, e.g., a recent review of the literature on the social impacts of GM crops in farming found that only four out of 99 studies on the issue had an empirical focus on the Global North [11]. Despite that Europe as a

region has experienced particularly fierce and long-term public opposition to GM crops [12], there does not seem to have been the same significant debate in academia about the role of GM crops for European farmers as there has been concerning African farmers [2,11].

In an attempt to move beyond this concentration on the Global South, which has persisted for over 15 years, in this study we compared the GM literature focusing on Africa with that focusing on Europe. We examined issues raised in the literature on GM crops in Europe and Africa and what could be gained from more interaction between these two seemingly separate domains of academic debate. The study focused on publications broadly classed as 'social sciences'. The reason for this was that we targeted publications discussing the wider implications of GM crops in agriculture rather than narrow technical papers, such as publications in genetics or molecular biology. Papers included in the review were those included the 'social science and humanities' subject area in the Scopus abstract and citation database. This subject area is defined in Scopus as including publications in arts and humanities, business, management and accounting, decision sciences, economics, econometrics, finance, psychology, social sciences and multidisciplinary research.

2. Background

2.1. What GM Crops Are Available on the Market Today and Where Are They Grown?

The GM crops available on the market today have been developed to suit large-scale, commercially orientated agriculture [1,13,14]. The most common GM crops are herbicide-tolerant (HT) varieties that possess resistance to broad-spectrum herbicides containing glyphosate. These were originally developed by the multinational biotech company Monsanto in a strategy to extend the commercial life of their key herbicide Roundup (resulting in Monsanto's Roundup Ready© crops) [15]. The HT crops were followed by Bt crops, modified to contain genes from the soil bacterium *Bacillus thuringiensis*. There are now also stacked-trait crops containing both these traits in combination [16]. The most common crops to be genetically modified today are, in order of appearance, soybean, maize, cotton and rapeseed. These together account for 99% of the global acreage planted with GM crops. The GM crops and traits dominating the market are still those that first gained the market share in the mid-1990s, the only significant change over time being that HT crops are gaining an increasing share [16]. Both HT and Bt crops are in essence developed to simplify farming for large-scale, capital-intensive producers. Despite GM crop seed generally being more expensive (differing between countries) than conventional seed, this extra input cost is generally economically justified in the case of large-scale farming, as it reduces management costs later in production [2]. Herbicide-tolerant crops reduce the weeding requirement, facilitate greater mechanisation and make it easier to farm very large fields [17,18]. Insect-resistant (Bt) crops reduce the labour requirements for crop inspection and/or applying insecticides, with associated reductions in fuel use [19]. However, these crops do not have the same obvious benefits for resource-constrained smallholders who seldom pay for labour. In cases where GM seed is accessible and not prohibitively expensive, smallholders can benefit from planting GM crops [2,11]. However, a focus on economic gain or loss hides other factors of relevance, one example being that in many cases the development of GM crops has been associated with a reduction in crop varieties suitable for marginal environments [20].

The first GM crops were grown there and today US farmers are the largest growers of GM crops in the world, followed by Brazil, Argentina, India, Canada and China. While public opposition to GM crops in the US has been limited, in Europe it has been particularly strong [12]. In general, legislation regarding food production or food items can be implemented by the European Union (EU) or by individual member states. In the case of GM crops, the policies have been adopted at the EU level, resulting in studies on GM crops concentrating on the EU level rather than the individual country level. Initial strong public resistance led the EU to introduce a temporary moratorium on new GM crop approvals between 1998 and 2003 [21]. However, since the moratorium was lifted, scarcely any GM crops have been approved for sale or planting within the EU and only Spain, where Bt maize is

planted, has any significant commercial GM crop production (although still minimal in comparison with the countries listed above) [16]. Moreover, recent EU legislation (Directive (EU) 2015/412) gives individual member states more freedom to ban or restrict the planting of GM crops approved at the EU level.

Although inconclusive, the literature investigating the reasons behind the public resistance to GM crops in Europe identifies a number of contributing factors. Some specific events occurring simultaneously or just preceding the first marketing of GM food, such as the emergence of mad cow disease (BSE) and the subsequent public mistrust in authorities that followed, cultural values attached to farming and food, and ethical and moral perspectives on biotechnology, have been acknowledged as important for European public scepticism to the technology [12,22–24]. Like the academic debate on GM crops and the poor, the public controversy around GM crops in Europe not only concerns domestic use but frequently extends to their role in the sustainable development of agriculture in the Global South [25–27]. Many have argued that the divergent positions of the US and EU have contributed to the current low adoption rates of GM in Africa [28–30], with only South Africa, Burkina Faso and Sudan having commercial plantations of GM crops [16].

2.2. The Corporate Framing of GM Crops as Technology for the Poor

Research by Glover [15] indicates that the focus on the Global South in public debates on GMO was partly a result of corporate strategy, as Monsanto, the largest producer of GM crops, started framing GM technology as a cornerstone in sustainable agriculture and a solution to world poverty and hunger already in the 1980s. What initially served the purpose of convincing company employees and shareholders to invest in agro-biotechnology during the 1990s also became a key outward marketing strategy of the company. In essence, poverty and environmental destruction were framed as very powerful problems to which GM technology was the ultimate solution [15,31]. However, this strategy encountered strong resistance in Europe, where anti-GM activists had already had a significant impact on public opinion and successfully reframed Monsanto's poverty and environmental focus as a way of luring small farmers into debt and impoverishment [15].

When the European market effectively closed in the late 1990s (with the moratorium entering into force), Monsanto had to find other markets and what had mainly been rhetoric then became action. The company invested significant resources in emerging markets in, e.g., Brazil, China, India and South Africa and started development programmes aimed at helping resource-poor farmers improve their food security and make their farming business-orientated [2,15]. It is notable that despite this significant attention to the developing world and small farmers, Monsanto's GM products remained mainly directed at large-scale, capital-intensive farmers [11,15,20].

Without specifying the extent to which corporate strategy has steered the debate towards the Global South, we conclude that both the academic literature and the public debate have concentrated significantly on the Global South.

3. Materials and Methods

In the present review, we performed a search for social science-orientated literature on GM crops in Europe and corresponding literature on GM crops in African contexts, in order to explore the nature and extent of North-South cross-fertilisation on the topic. The search was designed to be replicable. This means that some papers that could be of relevance to the topic, but that did not fit the pre-defined search criteria, were not captured. Based on tests of different search engines (Web of Science, CAB abstract, Google Scholar and Scopus), we concluded that Scopus produced the most relevant hits and selected it for the main search. To minimise exclusion of relevant papers, we designed the search to be as broad as possible while still generating a manageable number of hits.

The search was designed as follows: (farm* OR agricultur*) AND (biotech* OR "genetic* modifi*" OR GMO) and was limited to searching title, abstract and keywords of journal papers written in English, within the 'social science and humanities' subject area, published from 1999 (a year marking the beginning of increased attention in academia to GM crops in agriculture, as exemplified by the

report by the Nuffield Council on Bioethics [32]). The search rendered 1627 hits, of which two were duplicates. The final 1625 papers were imported to Endnote. As an indication of the variety of countries and regions discussed in the literature, all titles were inspected for geographical indicators. Of the 1625 papers, 500 had geographical markers in their title. In addition to country names, the following regions were mentioned in titles: EU or Europe (70 hits); Africa (Southern Africa, Western Africa, Sub-Saharan Africa) (42); Asia (including South-East Asia) (10); Latin America (eight); South America (two); and North America (two). Europe and Africa stand out as being mentioned frequently, despite having very limited GM crop cultivation, and are clearly of particular interest in research.

In total, including national and regional markers, 138 titles mention EU, Europe or specific European countries and 62 titles mention Africa or specific African regions or countries. After reading all abstracts, four of the 138 titles on EU/Europe were removed for not actually being about Europe (e.g., European referring to the European corn borer pest insect) or for not mentioning crop biotechnology or GM. Three African titles were removed for similar reasons. In addition, seven European titles and three African titles were removed for not providing an abstract. This resulted in a final total of 127 titles on EU/Europe and 56 titles on Africa. All abstracts and some full texts of these papers were read and classed inductively into categories based on the issue actually studied (i.e., the results) and not just mentions of issues, e.g., for the sake of contextualisation.

4. Results

Below we provide a short overview of the whole dataset and then narrow the focus to the literature on Africa and Europe.

4.1. Overview of the Dataset

Initial analysis of the geographical markers in titles revealed mention of countries in the Global South and also countries in the Global North with extensive GM crop cultivation, such as the US and Canada. The countries most frequently mentioned in titles and whether and how much GM crops are planted in these countries are shown in Table 1. Some countries were mentioned particularly frequently relative to their actual production of GM crops, e.g., the UK was the sixth most frequently mentioned country, but in fact has no commercial GM crops. On browsing through the titles mentioning the UK, it emerged that a significant proportion of the studies concerned discuss public and consumer attitudes and discourses on GM crops in farming (e.g., References [33–37]). This can be compared with the fact that Spain, which is the only European country with any significant commercial GM crop production, was only mentioned in four titles in the dataset (too few to be included in Table 1).

India (where GM crops are grown) was also mentioned very frequently. There are studies on public discourses on GM crops within this body of literature [38–40], but in comparison with the UK literature there is much more focus on effects on farmers and farming. In particular, economic, regulatory and policy factors influencing GM crop adoption by small-scale farmers are the subject of much attention (e.g., References [41–44]).

An interesting finding was that 10 of the 20 most frequently mentioned countries (in total 71 countries are mentioned in the titles) do not plant any GM crops at the moment (Table 1).

Table 1. Countries with five or more title hits in the material obtained from the Scopus search.

Country	Ranking Based on Number of Times Mentioned in Titles	Title Hits	Million Hectares Planted with Genetically Modified (GM) Crops (Source [16])	Global Rank according to Million Hectares Planted (Excl. Field Trials) (Source [16])
India	1	76	11.6	4
USA	2	61	73.1	1
China	3	37	3.9	5
Brazil	4	25	42.2	2

Table 1. *Cont.*

Country	Ranking Based on Number of Times Mentioned in Titles	Title Hits	Million Hectares Planted with Genetically Modified (GM) Crops (Source [16])	Global Rank according to Million Hectares Planted (Excl. Field Trials) (Source [16])
Canada	5	23	11.6	4
UK	6	23	0	No GM crops planted
Argentina	7	17	24.3	3
South Africa	8	17	2.7	7
Mexico	9	16	0.2	13
Kenya	10	15	0	No GM crops planted
Australia	11	14	0.5	11
Germany	12	13	0	No GM crops planted
New Zealand	13	11	0	No GM crops planted
Philippines	14	9	0.8	10
France	15	9	0	No GM crops planted
Japan	16	7	0	No GM crops planted
Switzerland	17	7	0	No GM crops planted
Netherlands	18	5	0	No GM crops planted
Nigeria	19	5	0	No GM crops planted
Uganda	20	5	0	No GM crops planted

4.2. Overview of Africa and Europe Literature

As regards Europe and Africa, the Scopus search results provided an indication about the countries, research institutions and subjects dominating research on these two continents. With regard to subject area, there were no marked differences between the two groups (Table 2). This indicates that any potential differences in topics discussed in these two bodies of literature arise from factors other than differences in academic subject area.

Table 2. Distribution of subject areas in hits mentioning Europe and Africa obtained in the Scopus search *.

	Africa		Europe	
	Number of Hits	Share of Subjects (%)	Number of Hits	Share of Subjects (%)
Social Sciences	49	38	88	30
Economics, Econometrics and Finance	17	13	34	12
Agricultural and Biological Sciences	16	12	45	15
Biochemistry, Genetics and Molecular Biology	14	11	24	8
Business, Management and Accounting	10	8	19	6
Environmental Science	10	8	35	12
Chemical Engineering	8	6	4	1
Arts and Humanities	5	4	8	3
Energy	3	2	2	1
Multidisciplinary	3	2	10	3
Medicine	2	2	2	1
Nursing	2	2	0	0
Engineering	0	0	13	4
Decision Sciences	0	0	3	1
Computer Science	0	0	2	1
Psychology	0	0	2	1
Earth and Planetary Sciences	0	0	1	0
Mathematics	0	0	1	0
Total	**62**	**100%**	**138**	**100%**

* This table includes all 138 titles on Europe and 62 titles on Africa located in the Scopus search. The following analysis includes fewer papers, since those without an abstract or those that were off topic were later removed manually, as described in the Materials and Methods section.

Analysis of author affiliations by country showed that over 80% of the studies focusing on Europe were performed at research institutions in Europe. In contrast, only 30% of the studies focusing on Africa were performed at African research institutions. This is probably mainly attributable to the

higher concentration of universities in Europe than in Africa and the fact that many Africans who can afford to do so go abroad to study. Having so much research on Africa conducted outside Africa (whether by African researchers or not) raises concerns about African contexts and practices being 'othered' (cf. Reference [45]). This could result in conclusions drawn about the role of GM crops for African farming and farmers being based on less locally grounded knowledge of context and practices.

Studies by researchers in the US and UK dominated both the Africa and Europe literature. For the studies focusing on Africa, 22% of the authors came from the US and 15% from the UK, while for the studies focusing on Europe the corresponding values were 17% and 21%, respectively.

4.3. Categorisation of Africa and Europe Literature

The results of our categorisation of all Africa and Europe titles are shown in Table 3. Due to the inductive nature of the categorisation, it was not possible to draw any reliable quantitative conclusions from the results. However, we used the categories to identify interesting areas for further deliberation, such as categories containing many papers and categories showing clear differences between the Africa and Europe literature.

Table 3. Description of classification categories and proportions of papers on Africa and Europe (number/total and %) falling within the different categories. Categories containing over 20% of papers marked in bold.

Category	African Literature	European Literature	Description
Capacity building/knowledge transfer	(7/56) 13%	(2/127) 2%	Studies on building capacity or knowledge and information transfer on GM crops/biotechnology.
Co-existence	(0/56) 0%	**(26/127) 21%**	Studies discussing co-existence in its different aspects, from models of gene flow between fields to economic and policy implications from farm to societal level.
Consumer preferences	(2/56) 4%	(17/127) 13%	Studies of effects of consumer preferences.
Effects on farmers/farming	**(18/56) 32%**	(0/127) 0%	All studies discussing effects of GM crops on farm level, except specific co-existence studies.
Environmental impact	(7/56) 13%	(10/127) 8%	Within and beyond farm.
Ethics	(1/56) 2%	(2/127) 2%	Studies on the ethics of GM crop introduction or wider biotech development.
Europe and/or US affecting other countries	(6/56) 11%	(1/127) 1%	Implications of, e.g., EU or US policies on other countries.
EU/US conflict	(0/56) 0%	(15/127) 12%	Studies on conflicts between EU and US in policy-making, e.g., impact on trade or explanations of different perceptions of biotech.
Gender	(1/56) 2%	(0/127) 0%	Rarely mentioned, but too distinct to be grouped with other categories.
Poverty/food security	**(17/56) 30%**	(0/127) 0%	Poverty or food security mentioned.
Factors affecting adoption	**(12/56) 21%**	(15/127) 12%	Studies discussing how and why farmers might adopt GM crops.
GM in media	(2/56) 4%	(9/127) 7%	Studies discussing the role of media or analysis of media discourses on biotech/GM technology.
Markets and international trade	(6/56) 11%	**(31/127) 24%**	Effects on markets and trade of EU policy-making, concentration of seed market, private R&D, international trade agreements, etc.
Patent/IPR	(3/56) 5%	(3/127) 2%	Studies on effects of patents on innovation and access to innovations; patent legislation in different countries, etc.
Politics/policy	**(26/56) 46%**	**(66/127) 52%**	Studies on policy and regulation on GM crops, political debates, etc.

Table 3. *Cont.*

Category	African Literature	European Literature	Description
Production	**(18/56) 32%**	(3/127) 2%	Studies on yield effects, farm management effects relating to production, such as insect management, herbicide spraying, etc.
Public engagement	(5/56) 4%	(7/127) 6%	Various mentions of public engagement, e.g., in risk assessment.
Public opinion	(6/56) 11%	**(30/127) 24%**	Studies of public opinion also without discussing engagement.
Risk	(9/56) 16%	(16/127) 13%	Studies on risk, uncertainty, precaution, biosafety.

As Table 3 shows, the largest category in the Africa literature was 'politics/policy' (46%), followed by 'effects on farmers/farming' (32%), 'production' (32%), 'poverty/food security' (30%) and 'factors affecting adoption' (21%). 'Politics/policy' was also the largest category (52%) in the Europe literature, followed by 'public opinion' (24%), 'markets and international trade' (24%) and 'co-existence' (21%). At first glance, politics and policy issues are thus clearly of high relevance in both the Africa and Europe literature. There was also an indication of a difference between the two groups, with the focus in the Africa literature more on production and productivity ('effects on farmers/farming', 'production', 'poverty/food security') and that in the Europe group more on choice (public (and other) opinion and 'co-existence').

We further analysed a selected number of categories that were most frequently occurring, or where there were marked differences between Africa and Europe. To facilitate discussion of the findings, we combined categories discussing themes that we considered similar into larger groups (Table 4). In both the Africa and Europe literature, there were clear parallels between the 'politics/policy' category and the categories 'markets and international trade', 'Europe and/or US affecting other countries' and 'EU/US conflict'. We therefore examined the major trends in the respective literature for these categories under the grouping 'policy and markets'. Another strand of research focused on farm-level impacts of GM crop introduction, covered by the categories 'effects on farmers/farming', 'production', 'poverty/food security' and 'factors affecting adoption' in the African literature, which were analysed together under the grouping 'farm-level impacts'. For the Europe literature, this grouping also included the category 'co-existence' (not present in the Africa papers), but not 'effects on farmers/farming' and 'poverty/food security'. Lastly, we examined consumer preferences/public opinion/public engagement categories, grouped as 'attitudes to GM crops' (Table 4). To indicate the relative size of each group, its share of the total number of categorisations is presented (as shown in Table 3, each paper could belong to several categories and thus it was not meaningful to add up the percentages shown in that table for each category, as that would have resulted in multiple counting).

Table 4. Groupings of categories representing strands of literature dealing with similar issues.

Group	Africa Literature Categories	Europe Literature Categories
Policy and markets	Politics/policy, Markets and international trade, Europe and/or US affecting other countries (26% of categorisations).	Politics/policy, Markets and international trade, EU/US conflict, Europe and/or US affecting other countries (45% of categorisations).
Farm-level impacts	Effects on farmers/farming, Production, Poverty/food security, Factors affecting adoption (45% of categorisations).	Production, Factors affecting adoption, Co-existence (17% of categorisations).
Attitudes to GM crops	Public opinion, public engagement, consumer preferences (9% of categorisations).	Public opinion, public engagement, consumer preferences (21% of categorisations).

4.4. Policy and Market Issues Researched in Africa and Europe

This group was the largest theme in the Europe literature (45% of categorisations), but in the Africa literature it represented only 26% of categorisations and instead farm-level impacts was the largest group (45% of categorisations) (Table 4). Despite the relatively small sample, some trends emerged in the Africa literature. One concerned the distributional effects of current trade regulations and GM policies, in particular how global trade agreements divert the sector away from smallholder needs and priorities and more specifically how smallholder access to suitable seed is constrained by the private industry dominance of the seed sector (e.g., References [7,46–49]). Within this theme, several papers discuss the types of national polices needed to facilitate smallholder adoption of GM crops and how to strengthen national plant-breeding institutions (e.g., References [50,51]). Another theme in the Africa literature concerned different regulatory approaches, how to raise biotech capacity in Africa and the potential economic effects at the national level of more restrictive and proactive policies on biotechnology [52,53]. A few papers discuss the effects of EU and US policy-making on African countries. Within this body of literature, there are contradictory conclusions about the extent and nature of EU and US influence on Africa [30,53,54].

Many of the policy papers focusing on Europe discuss why so few GM crops have been approved in the EU (so far only GM maize), the effects of this on the wider EU economy and trade, and the potential effects of a policy shift towards increased approval of GM crops. A substantial number of these papers portray the strict EU regulations as negative for the EU economy or trade, generally without being more specific about how or for whom this would be negative (e.g., References [55–58]). For example, Francis et al. [58] argue that the EU policy on GM crops not only prevents production of GM crops, but also causes the EU to lag behind as an agricultural region compared with the US and the Global South, as it results in higher than otherwise estimated levels of imports and less research and development.

The conflict between EU and US policy-making in this area comprised a category of its own, with 15 papers devoted to this issue in the Europe literature (Table 3). Several of these papers also analyse the impact on trade, while others attempt to understand the rationale behind the EU and US policies. The most common explanation for the differences between the EU and US in this respect is that while the EU has based its policies on a process approach employing the precautionary principle, the US has a product approach to risk assessment where genetic modification is not considered to differ per se from traditional crop breeding (e.g., References [33,59,60]).

While the majority of papers in the 'markets and international trade' category argue that EU regulations have trade-distorting effects, some papers have a wider scope. For example, Inghelbrecht et al. [61] discuss GM regulation as a 'wicked problem', as there is a large grey area where, e.g., ingredients in foodstuffs can be of GM origin while the product itself is not labelled GM and therefore is allowed on the EU market.

A comparison of the issues discussed in the Africa and Europe literature indicated more engagement in the former with how different policies affect farmers and how policy affects different types of farmers differently [7,49,62,63], whereas more of the Europe literature broadly discusses effects of policy on overall trade between the EU and countries outside the EU [55,56,58,64]. In both bodies of literature, attention is paid to the differences between and the effects of US and EU policies [30,33,53,54,59,60,65–69].

4.5. Farm-Level Impacts of GM Crop Introduction in Africa and Europe

In this group of papers, there were major differences between the studies on Europe and those on Africa. Beyond studies of co-existence, farm-level effects are almost not discussed at all in the literature on Europe, while this is the most common theme in the literature on Africa. While 'effects on farmers/farming' and 'production' are the two largest categories in the Africa literature, closely followed by 'poverty food security' (Table 3), 'effects on farmers/farming' and 'poverty/food security'

are not represented at all in the Europe group, and the 'production' category is represented by only two papers. Papers on co-existence are not represented at all in the Africa group.

Many of the studies discussing the effects of GM crop introduction at the farm level in Africa (Table 4) present findings from empirical studies on smallholder adoption of Bt cotton in South Africa (e.g., References [70–73]). The picture emerging from these studies is that both large-scale farmers and smallholders have benefited from higher yields and better household economics. Some studies from South Africa [62,74] and Burkina Faso [75] challenge the claim that these smallholder benefits derive specifically from Bt cotton technology and attribute them in many cases to the associated significant effort to create a favourable institutional framework for smallholders. A smaller group of studies on GM maize (HT and Bt) show a more complex picture where South African smallholders have not always benefited to the same extent as large-scale farmers, due to inappropriate varieties being modified, a lack of appropriate agricultural advice and high seed costs (e.g., References [7,76,77]). Two studies, one on HT maize [77] and one on Bt cotton [78], point out that adoption of GM technology has increased smallholder production risks due to higher seed costs and that such increased risks are not likely to be accepted by the poorest.

Most of the Africa literature focuses on the economic impact of adoption, while little attention is paid to why and how farmers chose to adopt. Interestingly, compared with the literature on Europe, discussed further below, no studies at all in the Africa literature examine the co-existence of GM crops with conventional or organic crops. However, some studies on Africa examine how to handle transboundary movement (i.e., movement of GM crops over country borders), which is one of the issues regulated under the Cartagena Protocol on Biosafety [79,80]. Further analysis of studies on co-existence in the entire dataset (1625 papers) revealed that the term is mentioned in 30 titles, with EU, Europe or specific European countries mentioned in 18 of these titles (no country is mentioned in nine titles and the US, Kenya and Australia get one mention each). This indicates that the debate on co-existence is primarily a European issue.

The few papers that discuss farm-level aspects in the Europe literature can be broadly divided into two main groups, discussing either co-existence (the largest group, see below) or factors influencing farmers' adoption of GM crops (in total 15 papers, five of which are also labelled 'co-existence'). Most of the papers on adoption are based on simulations of the effects of GM crop adoption by farmers. This set of papers includes contributions by Breustedt et al. [81] and Gyau et al. [82] investigating farmers' attitudes and willingness to adopt GM crops if they were permitted, and papers discussing the potential economic effects of farmers being allowed to adopt GM crops based on simulations (e.g., References [83,84]). Only three of 15 papers on GM crop adoption in the Europe literature go beyond economics and have a broader social science scope [85–87].

Only three papers in the Europe group deal with production aspects in existing production systems, two of which discuss the risk of cross-pollination [88,89]. One paper by Brookes [90] collates company data on commercial and field trial Bt maize crops in seven European countries and concludes that yields are higher overall. This represents a notable difference between the Europe and Africa literature, since the latter contains quite a significant number of papers based on site-specific data on the production of GM crops, as described above.

The papers dealing with co-existence can broadly be grouped into two dominating and partly overlapping themes concerning technical papers on the practical implementation of co-existence measures, mainly represented by studies modelling pollen-mediated gene flow for various crops (e.g., References [89,91,92]), and the economic effects for farmers of co-existence (e.g., References [87,92–94]). Most of the studies of the economic effects of co-existence predict that co-existence policies will hamper GM crop adoption and/or disfavour those farmers who want to plant GM crops (e.g., References [87,95–97]). An exception is the model presented by Ceddia et al. (2011) [98], which predicts negative economic effects of gene flow from GM crops on farmers who want to be GM-free.

A smaller group of studies on co-existence go beyond the farm and take a more critical approach to the concept, questioning the dominant policy frame of co-existence as a measure only for ensuring

farmers' and consumers' freedom of choice to respectively produce and consume GM products. These papers present a broader frame for co-existence, as an issue which cannot be separated from discussions on risk and precaution [99–101].

4.6. Attitudes toward GM Crops in Africa and Europe

This theme is much more frequently mentioned in the Europe than the Africa literature (Table 4). This broad set of papers deals with how the GM crop debate is discussed in the media, or reasons why consumers in Europe have rejected GM foods. Some discuss the GM debate at the European level (e.g., References [66,102]), and others at the national level (e.g., Reference [37]). Some papers describe the European policy on GM crops as a result of local resistance (e.g., References [24,103]). In the Africa literature, attitudes toward GM crops are discussed much less frequently (Table 4). There was a clear difference between the Africa and Europe literature in that the papers discussing public opinion much more frequently label people 'consumers' in the Europe literature, while only two papers in the literature on Africa do so [104,105]. More commonly, papers on attitudes in the Africa literature use other wordings such as 'the public' or 'stakeholders' [106,107]. This could be interpreted as showing that neoliberal jargon is more often used in the literature on Europe, reducing people to consumers.

5. Discussion and Conclusions

This paper examined issues covered by the social science literature on GM crops apart from food security and poverty in Africa, which has received significant attention in research and public debate in recent decades [20]. We compared the social science literature on GM crops in agriculture in Africa with the issues covered in the social science literature on GM crops in agriculture in a European context.

The results revealed a number of social science studies of GM crops focusing on contexts in Europe (Table 3). This appears to contradict findings in a recent review of the academic literature on social impacts of GM crops in agriculture [11], where only four of 99 publications reported results from the Global North. However, that review focused only on farm-level studies and studies addressing 'material' social impacts, such as effects on well-being, income, distribution, etc., and excluded studies of consumer behaviour, public perception and co-existence. As presented here, the broader social science literature on GM technology and farming contained a significant number of social science studies from the Global North, but these mainly address issues other than farm-level impacts.

There is frequent mention in the reviewed GM literature of countries with no GM crops planted (10 of the 20 most frequently mentioned countries in papers located in the present search), even though our search focused specifically on GM crops in agriculture. This indicates that the question attracts significant interest in the form of speculation about the future. A similar conclusion was drawn by Fischer, Ekener-Petersen, Rydhmer and Björnberg [11], who found that out of 99 studies on the social impacts of GM crops in agriculture published since 2004, two-thirds are based on previously published empirical evidence. The present comparison of literature on Europe and Africa indicated that empirical research is particularly lacking on Europe. There are many studies on European attitudes to GM technology (e.g., References [35,68,69,82,85]) and simulations of future scenarios (e.g., References [57,88,93]). However, there are few empirically based studies on GM technology in agriculture in Europe. This is seen in the general lack of studies on the farm-level impact in the Europe literature as described above. It is also seen in the comparatively few studies focusing on places were GM crops are actually planted in Europe (such as Spain with only four title hits), whereas comparatively significant attention is paid to countries in Europe who do not currently plant GM crops, but who might exert a comparatively strong influence on EU politics, such as the UK and Germany (Table 1). A comparison of the Africa and Europe literature revealed clear differences in the dominant themes, but also similarities. Most studies in all categories directly or indirectly examine how to facilitate GM crop adoption, e.g., through stimulating public acceptance, designing policies for research and development, farming and trade that facilitate the use of GM crops, etc. The general trend is thus an absence of more critical literature on the topic. There are a few clear exceptions for both Europe and

Africa (e.g., References [62,108,109]). It is interesting to note that the wider social science literature on GM crops in the Global South has contained significant criticism of how technology, regulatory and trade trajectories have marginalised weaker actors (e.g., smallholder farmers, developing countries), but this theme does not dominate the literature on Africa. One likely reason was that the selection of papers for this review was based on geographical markers, as many papers discussing this issue do not concentrate on a specific geographical region [9,110]. Another reason might be that this type of criticism is more common in research on Latin America [10,17,111], as also indicated by Fischer, Ekener-Petersen, Rydhmer and Björnberg [11].

Overall, the material reviewed here revealed a significant difference between the literature on Europe and that on Africa. A large proportion of the Africa social science literature is directed at the farm level and production, while in that dealing with Europe farmers are practically invisible and instead the focus is on European GM policy and on consumer and public resistance to GM crops.

The strong focus on consumers in the Europe literature can be seen as part of a strong neoliberal trend where the role of agriculture in Europe has shifted from the production of food by farmers to the consumption of natural/cultural heritage by consumers, including an increasing focus on added value in, e.g., artisanal food products [24,112]. Over recent decades, EU Common Agricultural Policy has been increasingly directed towards consumers. Although the EU spends large amounts of money on agriculture every year, an increasing share of that budget goes to broader rural development projects and to paying farmers to manage cultural landscapes rather than to produce food. Attention to agriculture is thus not the same as attention to agricultural production. We see the focus on co-existence in the Europe literature as one example of this trend. Most of the studies reviewed here do not question the dominant policy frame of co-existence as a simply technical measure to ensure freedom of choice through separate value chains for GM and non-GM produce (e.g., References [87,96,97]).

The current lower priority of agricultural production in Europe and the higher focus on producing value-added products and marketing food with a particular local identity can partly explain the general failure of GM crops to enter the EU market [24]. The existing GM crops are tightly bound to an agri-industrial model that is not prioritised in Europe [113], but which is presented by many as a central solution for problems of poverty and food security in the Global South [20].

Although a neoliberal trend is definitely also apparent in African agricultural policy [114], it has taken a different form there, with the focus on raising agricultural production and achieving 'a new Green Revolution' [20]. The greater focus on farming rather than on consumers in the Africa literature may also reflect the importance of subsistence farming in many African countries and the relatively low commercial integration of farming into national and global value chains and markets. This means that consumer influence on agricultural development is weaker or at least more difficult to study, as it has to occur outside formal market chains. However, in recent years the commercialisation of smallholder agriculture has been mentioned by many as a key pathway for helping rural Africans out of poverty [115,116]. If domestic African agriculture is to feed a growing urban population, consumer choice is likely to be a more important issue on the agenda in the future.

Lastly, it can be noted that with the general lack of attention to farming and farmers in the Europe literature, there has been an associated lack of refinement of this topic. As mentioned earlier, much of the research on Africa is performed outside Africa and this could be expected to make the work less locally grounded. However, our analysis indicated the opposite, with the Africa literature frequently being based on local empirical material such as surveys or dedicated interviews with farmers (e.g., References [62,71,77]). In contrast, the Europe literature is generally much more abstract, drawing on large, externally derived datasets, simulations and predictions about the future [81–83,93,117–119] or calculations of how much farmers are losing economically from not being allowed to plant GM crops [84]. One paper in the Europe group (on Scotland) stands out as having empirically investigated farmers' attitudes to GM crops [85]. The literature on Africa also has a much stronger focus on farming, with a number of studies on how GM crop adoption affects different types of farmers, e.g., smallholders versus large-scale farmers [7,70,120]. The Africa literature also contains the only gender-sensitive

study on GM crops found in this review [63]. In contrast, this issue is completely overlooked in the Europe literature reviewed here. It should be noted that this is not because all farms and farmers within Europe are similar, e.g., the European Network for Rural Development [121] estimates that there are well over 10 million smallholders in Europe. Thus, it is clearly time to go beyond focusing on the use of GM crops for poverty reduction in Africa and draw lessons from the Africa literature to conduct appropriate empirical research in Europe.

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