

Pesticides Risks in Africa

Subjects: [Agriculture, Dairy & Animal Science](#) | [Environmental Sciences](#) | [Others](#)

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On the African continent, ongoing agriculture intensification is accompanied by the increasing use of pesticides, associated with environmental and public health concerns. Agriculture production systems are at the same time under pressure due to climate change, the need to produce about double the amount of food by 2050, and to achieve some of the sustainable development goals (SDGs).

agriculture

environmental risks

exposure risks

food production

pesticide

africa

sdg

1. Introduction

In Sub-Saharan Africa (SSA), agriculture represents an economically important sector, contributing to the livelihoods of rural families and employing the biggest and still growing workforce ^[1]. Agriculture production systems are at the same time under pressure due to climate change ^[2], the need to produce about double the amount of food by 2050 ^[3], and to achieve some of the sustainable development goals (SDGs) ^[4]. Therefore, a “new green revolution” has been propagated, which is resulting in substantial land-use change and intensification ^{[5][6]}. The transition of these mostly smallholder farms to larger conventional agricultural entities requires additional agrochemical inputs ^[7]. Across all 46 countries in SSA, the Food and Agriculture Organization of the United Nations (FAO) estimated that pesticide use increased by 1.5 times between 2006 and 2019, reaching more than 100 kg tons per year ^[8]. Despite being banned in Western countries, several persistent and highly hazardous insecticides (such as organochlorines (OCPs), organophosphates and carbamates) are still frequently used and exported to SSA ^{[9][10]}. Overall, this leads to situations where there are hundreds of different current-used pesticide (CUP) formulations in use, consisting of multiple active ingredients ^[11] with established environmental and public health effects ^{[12][13]}. This results in exposure to pesticide mixtures that can act cumulatively or synergistically on non-target organisms, including humans ^[14]. At the same time, there is an ongoing shift towards agriculture that uses more herbicides and fungicides (e.g., due to no-tillage farming ^[15] or greenhouse-based horticulture systems, such as flower farming ^[16]). There are gaps in pesticide use data (e.g., no current data exists for Nigeria ^[8]) or assumptions are based on generic sales data (e.g., in South Africa ^{[11][17]}). Outdated information on pesticide use creates misinformation on current agriculture practices and related risks.

There are only a few research studies on environmental occurrence ^{[18][19]} or human exposure and health outcomes of pesticides ^[20] in low- and middle-income countries (LMICs), with particular research gaps in SSA. Additionally, research studies in LMICs often have a disciplinary focus on a specific environmental matrix (e.g.,

water [21], soil [22], or dust [23]); knowledge, attitude, and practice (KAP) of users [16][24][25]; human exposure; and health risks for farmers and farmworkers and vulnerable groups, such as women and children [24][25]. A context-specific overview or an integration of findings across research studies from different matrices and population groups is therefore often missing. However, such an overview would be valuable to inform and guide possible interventions to reduce environmental and public health risks. In light of the expanding agriculture sector and the growing and aging population in SSA, an integrated understanding and monitoring of pesticide pollution combining information from environmental, food, and health systems are therefore needed to achieve several of the SDGs [26].

2. Pesticides Risks in Africa

With the observed increased pesticide use in SSA, there is a potential of increasing environmental contamination and acute and chronic health effects after occupational and environmental exposure. This systematic research assessed whether research findings from the region can provide relevant interdisciplinary data for risk reduction and policy interventions. Researchers identified five distinct geographical hot spots where most of the identified research was concentrated: two in South Africa, one in West Africa, and two in East Africa. The major research focus was on insecticides like OCPs and OPs, while health effects of exposure to herbicides and fungicides were seldomly studied, and neither was there a focus on multiple pesticides and their mixtures. Most studies collected environmental samples but only a few environmental risks. Human risk assessments were dominated by model-based risk assessment on measured environmental samples (mostly food and drinking water) and entailed mainly unspecific health risks (e.g., levels above/below maximum residual limits). The few epidemiological studies assessed mostly self-reported symptoms and diseases in small cross-sectional designs. Epidemiological studies applying longitudinal designs, detailed exposure (e.g., biomarkers or algorithms) and health assessments were very limited, even more so limited with a focus on children or women.

The five identified geographic research hotspots in SSA can be described as follows. In the Western Cape in South Africa, the research has been focusing on pesticide use for export-oriented fruit and wheat farming. Most studies were conducted along with the cohort CapSA, which included environmental assessments, exposure, and health assessments of 1000 children living on and off farms [21][22][27][28][29]. In the northeastern region of South Africa [30][31] many studies could be linked to the cohort VHEMBE or the cohort “Occupational health needs of women working on small-scale and emerging farms”, and studies were conducted on pesticide use and its health implications also for woman and their children [32][33]. In East Africa, the PESTROP [24][34][35][36][37][38] and the PEXADU cohorts [25][39] studies in Uganda produced findings on environmental contamination, KAP of pesticide use, and health implications. While other studies focused on water bodies in Kenya [40]. In Ethiopia, several research efforts were conducted around the flower and larger open-farming systems in proximity to the Rift Valley lakes [16][41][42][43][44]. Finally, in West Africa, several connected studies focused on different export-oriented farming systems (e.g., cotton and cocoa) and smallholder farming systems [45].

There were 14 articles that spanned across countries. Four studies included even worldwide perspectives of OCPs occurrence in air [46], neonicotinoids environmental and human risks in honey [47], pesticides on wristbands [48], and

pesticide-related health effects among smallholder farmers [49]. Two studies assessed KAP of different farming communities [50][51], one on dietary contamination [52], one on fish [53], and three on water [54][55][56]. Seven studies focused on legacy persistent pollutants [57][58] or CUPs in air [29]. Overall, most of these studies focus on past used (legacy) pesticides, while long-term monitoring of CUPs was studied less, and in the case of human exposure (e.g., human biobanks), studies were nonexistent. This makes it difficult to study long-term trends and risks around current agricultural production across SSA.

The focus on OCPs, which are banned for agriculture use, can be explained due to their extensive past use and current use for malaria vector control. Across SSA, most studies found considerable levels of DDT in water, air, soil, human blood [59], or breast milk [60] samples, and its health effects have been reported [61]. The studies raised awareness to reduce human and environmental exposure and possibly a need to reduce the extensions under the Stockholm Convention for vector control. Highly hazardous organophosphates and carbamates were also frequently researched [21][22][62]. Many organophosphates are banned or phased out in high-income countries. Within SSA there are several efforts to regulate these highly hazardous pesticides (HHP) [10], however, with limited success so far [63], as, for example, measured levels in air indicate [29]. There was a critical research gap observed in research on herbicides and fungicides despite herbicide use being the highest of all pesticides in many countries (e.g., South Africa [11]). According to FAO, these two types are currently dominating the total use of pesticides globally and also within SSA [8]. Even though most of the herbicides and fungicides have low acute toxicity, there are often associated with being neurotoxins, endocrine disruptors, or carcinogenic as a result of low-dose long-term exposures [64]. A few of the reviewed studies point out the health risks of herbicides (e.g., glyphosate [34]) and fungicides (e.g., mancozeb [24]). Most studies focused on the one-exposure one-disease approach, taking into account only single effects of pesticides, while several studies investigating use [65][66][67], environmental occurrence [55][68][69][70][71], and human exposure [48][72][73][74] showed that exposure happens from multiple pesticides over time, which could potentially result in cumulative and synergistic environmental [21] and public health effects [24][34]. The missing research on multiple pesticides could be due to the challenges with analyzing these pesticides in local laboratories [75][76] and knowledge gaps with data analysis techniques [34].

Environmental samples were mostly clustered around larger aquatic ecosystems [77][78][79][80][81] and were integrating measurements from water, sediment, or aquatic organisms. Further using passive air [29][46][70][82] and water [21][83][84] sampling systems, several pesticides in the chemical groups of the OCPs and OP, carbamates, and triazine could be detected over several years in different regions across SSA. Indeed, such samplings could define exposure windows over time and space to multiple pesticides and lay a basis for risk assessments. However, among the studies that collected environmental samples, only a few assessed environmental [21][85][86] or human health risks [22][84][87][88][89]. Indeed, in several cases, there are no contextual environmental risk thresholds available. The studies that applied a risk assessment mostly compared it to EU or U.S. standards. The human health risk assessments were dominated by model-based risk assessment from environmental samples (mostly water [90][91][92] and food [93][94][95]). This might be partly explained by monitoring programs of local water authorities and the focus on export industries, which require testing for residuals in food and flowers. Hence, there are efforts needed to link environmental monitoring campaigns with environmental and human health risks assessments and define context-specific risk thresholds.

The majority of the epidemiological studies were small and assessed self-reported health outcomes cross-sectionally. Only 18 prospective longitudinal studies exist. Out of the 18, in nine objective exposure [25][32][62][96][97][98][99][100][101], in five objective health outcomes [25][62][97][98][102], and in three pesticide dose-response relationship were assessed [25][62][97]. Longitudinal studies provide the best quality evidence but are so scarce that it impacts the quality of evidence for contextual decision making and appropriate mitigation of possible risks. Studies on children and on women were also underrepresented even though they are mostly more vulnerable (e.g., during puberty or pregnancy, respectively) and have different exposure pathways, resulting in different risks linked to the agricultural tasks they perform [42]. To overcome the issue of low-quality evidence, birth cohorts, large biobanks and disease registries should be established across SSA. In addition, health information systems or cohorts in agriculture areas designed to monitor other risks factors (e.g., malaria, HIV) could be considered to co-investigate the risks of pesticides. Moreover, there is a complete absence of data about effective interventions to reduce pesticide use in agriculture (e.g., randomized control trial (RCT) to monitor the effect of training on exposure and risk reduction). The four existing intervention studies were all non-randomized and partly did not compare with a control group [103][104][105][106]. Hence, RCTs applied to intervention studies and targeted to local settings are considered the highest priority for decision making [62].

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