PESTICIDE RESIDUAL EFFECTS ON CROPS AND CROP RESIDUES FED TO RUMINANT ANIMALS: A REVIEW

[1]*Mustapha, H., [2]Gilima, Z.S., [1]Ibrahim[1], R.S., [3]Abbas, M.W., and Nasiru, A.

[1]Department of Animal Science, Faculty of Agriculture, Bayero University, Kano Nigeria
[-] Department of Crop Protection, Faculty of Agriculture, Bayero University, Kano Nigeria
[+] Institute of Grassland Science, School of Life Sciences, Northeast Normal University, Changchun, China.
***Corresponding author: hassanmustapha1474@gmail.com +234-8136753331**

ABSTRACT
The FAO defines pesticide as a mixture of chemical or biological components designed to repel, destroy or control pest, or to regulate plant growth. Pre-and post-harvest use of pesticides safeguards crops and controls pests and improving production yield. The residue problem in food products is mainly due to the persistent use of pesticides as well as to their injudicious use. However, following "Good Agricultural Practices" is an option that implies a thorough understanding about the use of various pesticides in an effective and eco-friendly way. Without the use of pesticides, there would be a 78% loss of fruit production, a 54% loss of vegetable production, and a 32% loss of cereal production. Therefore, pesticides play a critical role in reducing diseases and increasing crop yields worldwide. Certain pesticides can persist and accumulate in animals for extended periods of time due to their high stability and solubility in fat. As a result, there is growing concern about the potential risks posed by these residues to livestock and their products and human health. pesticide regulation in animal feed plays an important role because it can affect the health and quality of livestock products. Therefore, they use should be regulated and monitor, similarly MRL for each active ingredient should be established and check over time particularly in the developing countries.
Keywords: Pesticides, Crop Residues, Nutrition, Livestock, Feed

INTRODUCTION

The FAO defines pesticide as a mixture of chemical or biological components designed to repel, destroy or control pest, or to regulate plant growth (FAO 2018). Pre-and post-harvest use of pesticides safeguards crops and controls pests (like insects, weeds and plant pathogens), improving production yield (Ozkara, Akyil, & Konuk, 2016). According to recent chemical use surveys in the United States, pesticides were applied to more than 94% of the total number of acres planted with peanut in 2018 (USDA-NASS, 2019), 93% of acres planted with cotton in 2019 (USDA-NASS, 2020), and 96% of acres planted with corn in 2021 (USDA-NASS, 2021). Application errors when applying pesticides are common (Luck, *et al.;* 2011) and several factors, including selection of nozzle size or type, spray volume, spray pressure, ground speed, and boom height (Balsari, *et al.;* 2017). The residue problem in food products is mainly due to the persistent use of pesticides as well as to their injudicious use. However, following "Good Agricultural Practices" is an option that implies a thorough understanding about the use of various pesticides in an effective and eco-friendly way. It's on this basis that this literature review paper seeks to explore; Pesticide Use on Crops, Pesticide Residue Levels in crops, Regulatory Frameworks and Monitoring, and Transfer of Pesticide Residues to Animal Products.

Pesticide use on Crops

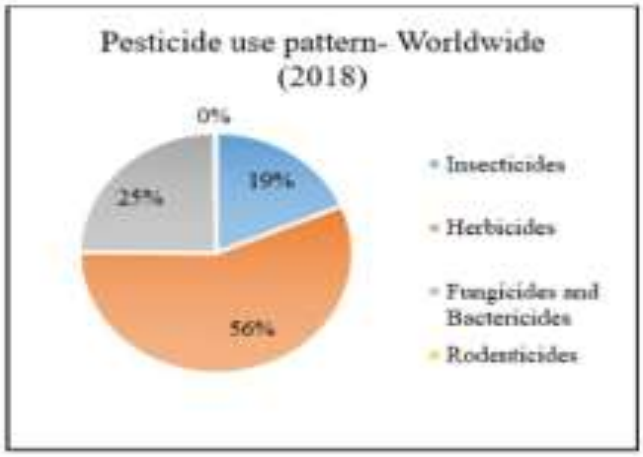
Pesticides are very essential in agricultural production. They have been used for decades by farmers to increase agricultural productivity through control of weeds and insects. The increase in the world's population in the 20th century could not have been possible without a parallel increase in food production. About one-third of agricultural products are produced depending on the application of pesticides (Table 1 and Figure 1). Without the use of pesticides, there would be a 78% loss of fruit production, 54% loss of vegetable production, and 32% loss of cereal production. Therefore, pesticides play a critical role in reducing diseases and increasing crop yields worldwide. (Tudi, *et al.;* 2021). Pesticides are classified by different classification terms such as chemical classes, functional groups, modes of action, and toxicity (Garcia*et al.;* 2012). A closer look at pesticide use finds that we're using more pesticides and treating crops more frequently than ever before. Global pesticide use (in tons of active ingredient) increased by 46% between 1996 and 2016, according to the FAOSTAT database WHO (2019). Currently, around four million tons are used per year on a global basis, most of which are herbicides (56%), followed by insecticides (19%), fungicides (25%) and other types such as rodenticides and nematicides FAO (2018) while only 1% of total pesticides are effectively used to control insect pests on target plants (Bernardes, *et al.,* 2015). The large amounts of remaining pesticides penetrate or reach non-target plants and environmental media.

Table 1. Global distribution of pesticide usage on average for 1990 to 2018, based on data from FAO (2019).

	continents				
	Asia	Americas	Africa	Europe	Oceania
Usage (%)	53	30	2	14	1

Fig.1 Worldwide pesticide usage pattern over the years. (Nayak and Solanki, 2021)

Transfer of pesticide residues to livestock



Pesticide residues in livestock generally accumulate in two ways: either through direct application to animals or through direct application to agricultural and fodder crops (Poppenga, 1999). The livestock reared on pesticide contaminated soils, crops, and fodders may accumulate considerable residues in edible tissues. Animals can accumulate these substances from contaminated feed and water. Moreover, due to the lipophilic nature of pesticides, they easily accumulate in milk and other fat-rich substances (John, *et al.,* 2001) which relates to an indirect source of pesticide accumulation represented by animal-derived products. Certain pesticides can persist and accumulate in animals for extended periods of time due to their high stability and solubility in fat. As a result, there is growing concern about the potential risks posed by these residues to livestock and their products and human health. Some of the ways by which pesticides enter the animal system include chemicals used in treatment and control of ectoparasites in livestock; the ingredients of concentrated feed such as cottonseed cakes, grains, brans, and pulses; the feeding of contaminated unconventional feed, i.e., vegetable waste from local markets; drifting during spray on other crops; the use of contaminated irrigation water in fodder growing fields; and pesticide dusting in orchards where fodder intervention is conducted. The continuous intake of pesticide residues in ruminants is a particularly serious problem in the case of the organochlorines, which are highly liposoluble and deposited in adipose tissues, body fats and remain in situ for a long time.

Pesticides residues in meat and milk of ruminants' animals

Pesticides applied during the production, transportation and storage of crops might withstand the processing treatments and remain present in the final product (Nag, 2006). Literature surveys, reveal four main classes of pesticides that had been detected in animal-derived foods, categorizes as organochlorines, organophosphates, carbamates and pyrethroids (Thomas, and Unni, 2019). These pesticides vary in terms of their constituents, lipophilicity and degradability in the environment. In a study conducted by Nida', *et al.;* (2009) revealed the presence of Organochlorine pesticides (OCPs) residues in milk, butter, cheese, labaneh and yoghurt owing to their use in sanitary and agricultural purposes. Out of the 233 dairy product samples that were analysed 48 (20.6%) samples were found to be contaminated with different OCP residues. A study conducted by (Meligy, 2019) reveal the presence of Diazinon in muscle and liver tissues of all the study animals while other pesticide were reported to be species specific. The frequency of detection of DDT in meat is higher in developing countries than in more developed ones. Out of the 90 carcasses analyzed by Sallam, *et al.;* (2007) in their study, 43.3%, 63.3%, and 56.7% camel, cattle and sheep carcasses respectively were positive for DDTs, with an overall detection of 54.4% among analysed samples of the three species.

Regulatory Frameworks and Monitoring

Among all major sectors in the livestock-product supply chain (i.e., fodder crop cultivation, feed derivation, livestock farming, raw food production, industrial processing, transportation and retailing, and customer consumption) pesticide regulation in animal feed plays an important role because it can affect the health and quality of livestock products. Efforts have been made to define Maximum Residue Levels (MRLs) of pesticides in feed (Handford, *et al.* 2015). The European Union (EU) established a framework for regulating chemical substances in feed, which aims to protect animal health and ensure the quality of foods of animal origin. European Commission, (2002) reported that most current MRLs for feed are defined using pragmatic approaches (i.e., default or empirical values) rather than science- or risk-based assessment (i.e., mechanism-based residue

transfers models), which is mainly due to current data limitations. However, unlike pesticide regulations in crops or foods of animal origin that are directly linked to human consumption, the management of pesticide residues in feed must consider both upstream (i.e., fodder crops) and downstream (i.e., animal health and food safety) sectors in the livestock-product supply chain. In current MRL regulations (e.g., EU and Codex Alimentarius), there is a lack of connection among different MRL-related components (i.e., feed materials, animal feed, and foods of animal origin), rendering an impact analysis of pesticide MRLs throughout the livestock product supply chain difficult. Thus, the derivation of MRLs in feed is challenging because this process involves the combination of chemical-plant, plant-animal, and animal-region specific migration of pesticides from animal feeds to grazing animals.

CONCLUSION

The increase yield of agricultural produce is greatly influenced by the use of pesticides which make it more indispensable. However, the injudicious use of these synthetic chemicals has significant negative impacts on the environment, livestock and human. Therefore, they use should be regulated and monitor, similarly MRL for each active ingredient should be established and check over time particularly in the developing countries.

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