

Ten years of Lignin in the Agro-food industry: Research trends and evolution

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Introduction

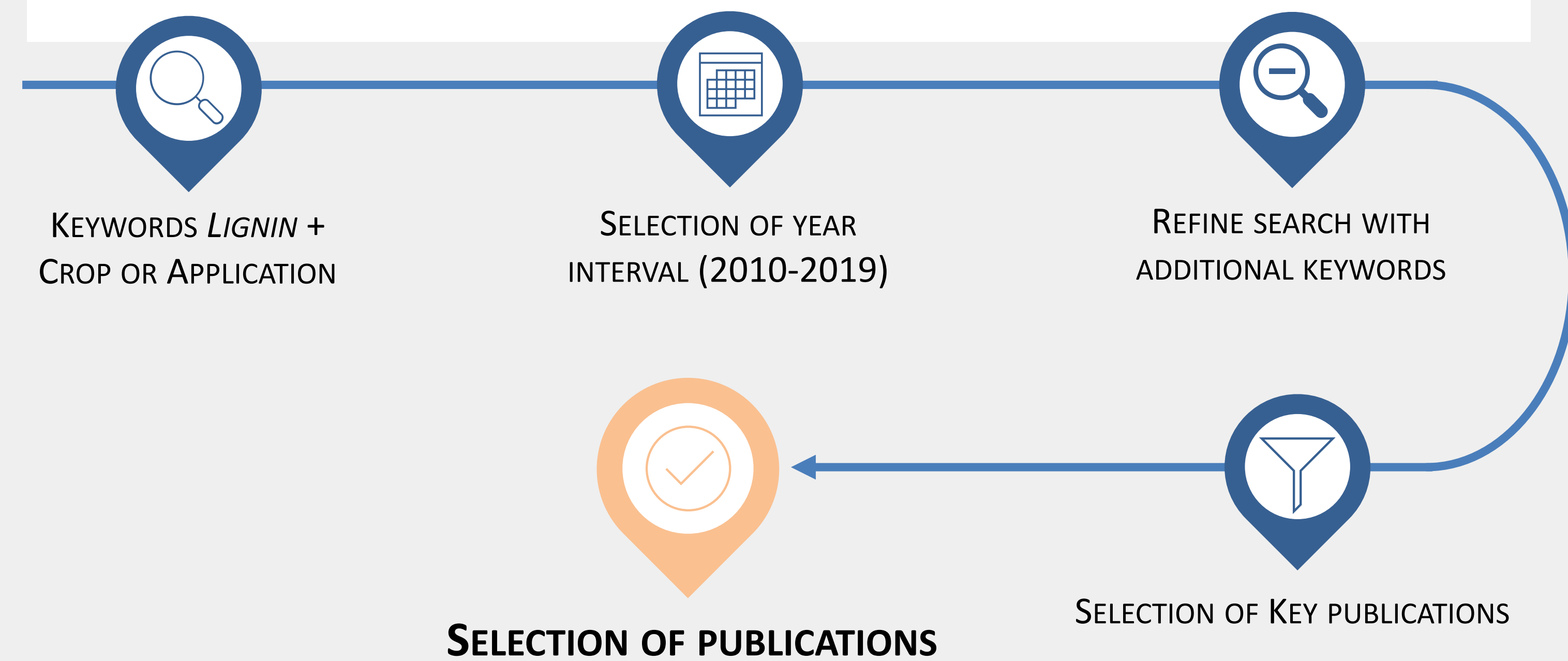
Lignocellulosic biomass is an important renewable resource since it is the most abundant biomass in the world¹. Presently, most of the lignocellulosic residues are considered non-valuable, frequently disposed through burning². Specifically, lignin is still unappreciated despite being a promising polymer with many valuable properties^{2,3}. The agro-food industry is responsible for producing large quantities of residues that are possible sources of high-quality lignin. In turn, the extracted lignin can be applied in the agro-food industry. Considering the circular economy concept, this review provides an overview of the research evolution and trends on lignin from agro-food industry, over the last decade. The aim is to understand if there is an increase of interest and which is the path that investigation on this topic is heading to.

Outputs

Regarding sources of lignin, the crops with the highest production - sugarcane, maize, rice and wheat - are also the most studied. Often, lignin is extracted from production residues e.g. bagasse, husks, peels, prunings. The most common extraction methods identified were alkaline (Ak), organosolv (O), acid (Ac), autohydrolysis (HW), ionic liquids (IL), enzymatic hydrolysis (Enz), steam explosion (SE), microwave (MW), deep eutectic solvents (DES) and dioxane (D). Concerning the applications, about 50% of publications refer to lignin application in polymers and 20% to its antioxidant potential.

Methods

Recent literature on the potential sources and applications of lignin from Agro-Food industry (2010-2019) was collected through several searches on ISI Web of Knowledge (WOK). The search was conducted using combinations of keyword *lignin* with the different keywords related with the sources and applications.



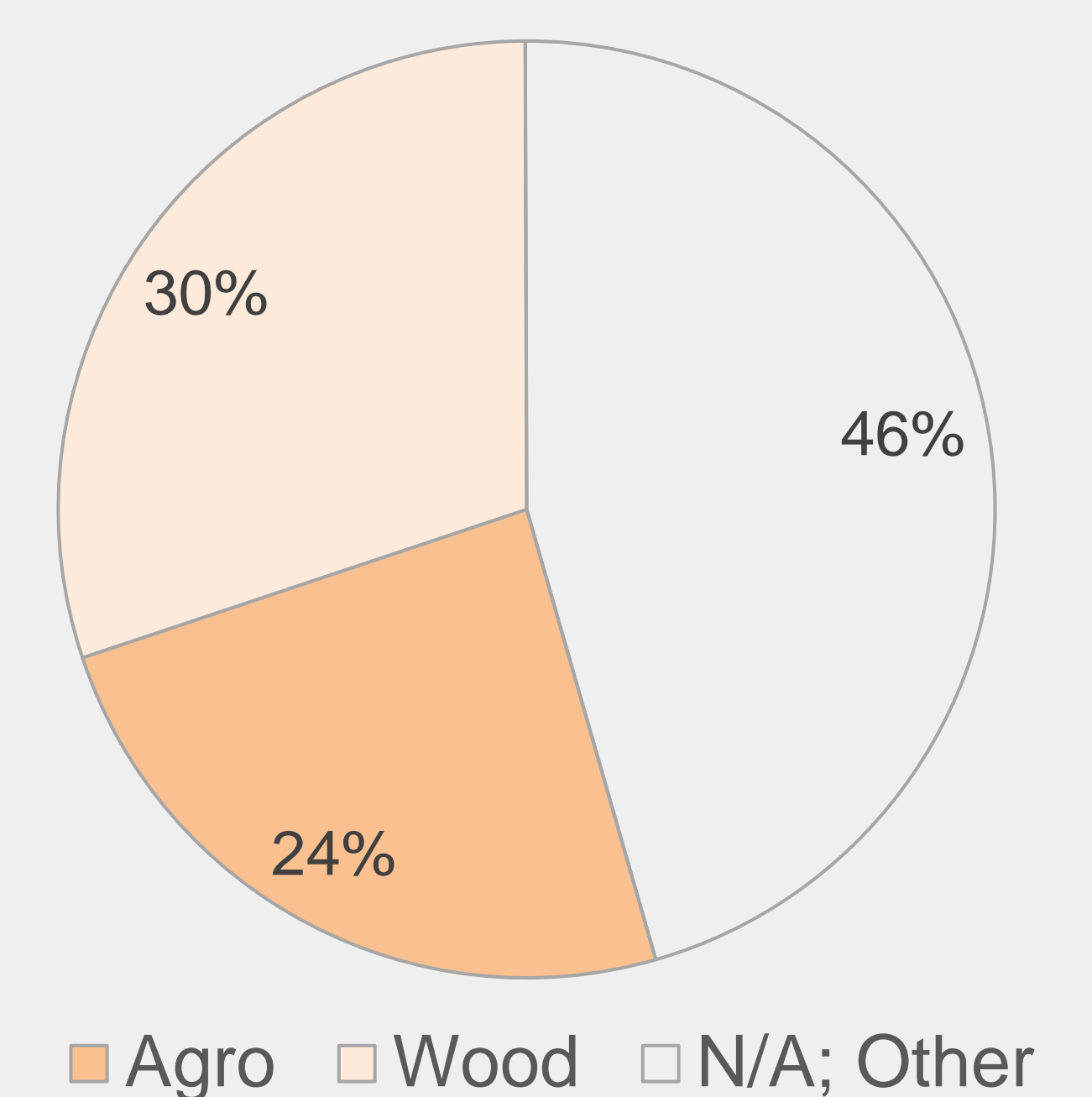
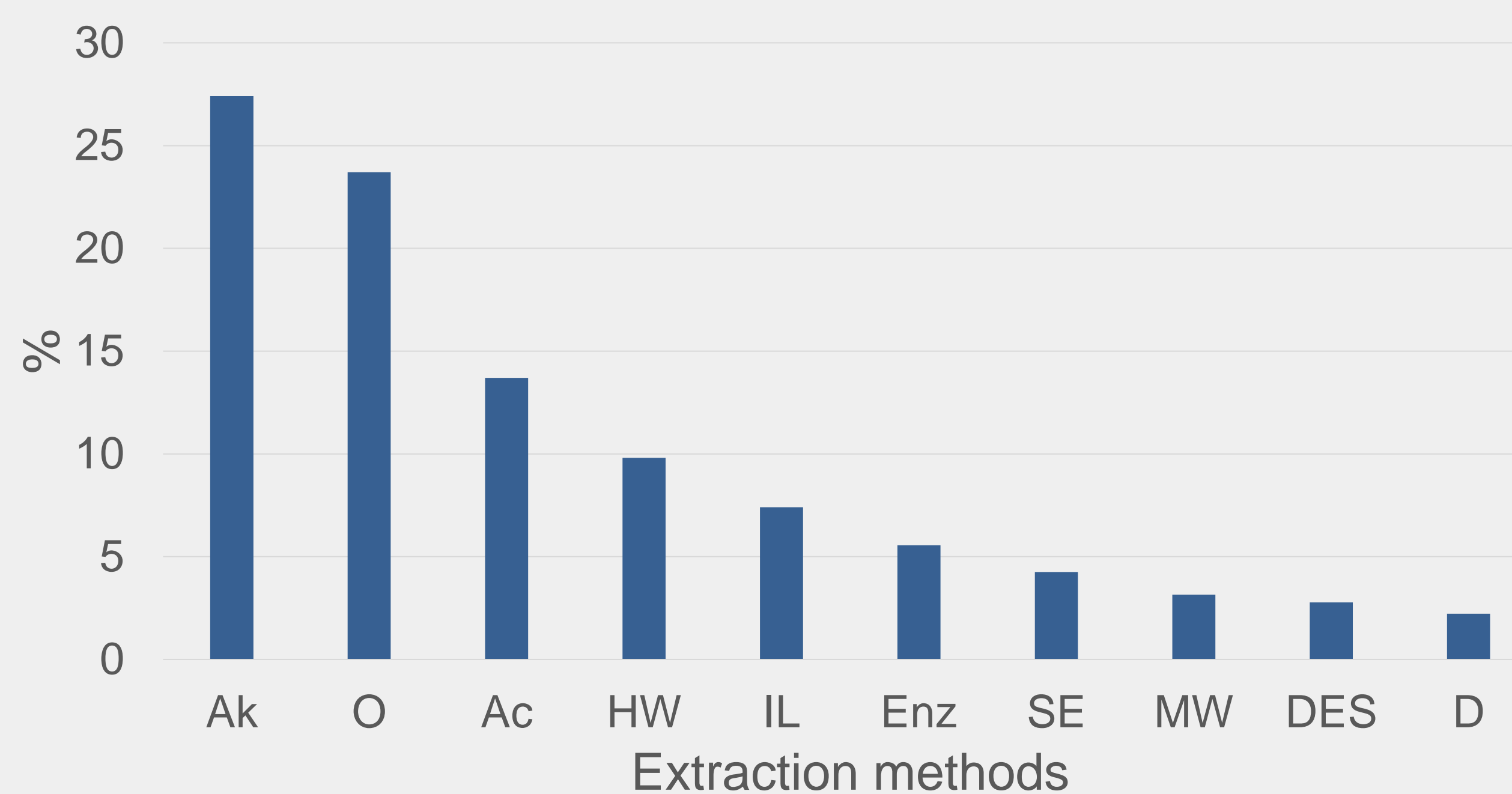
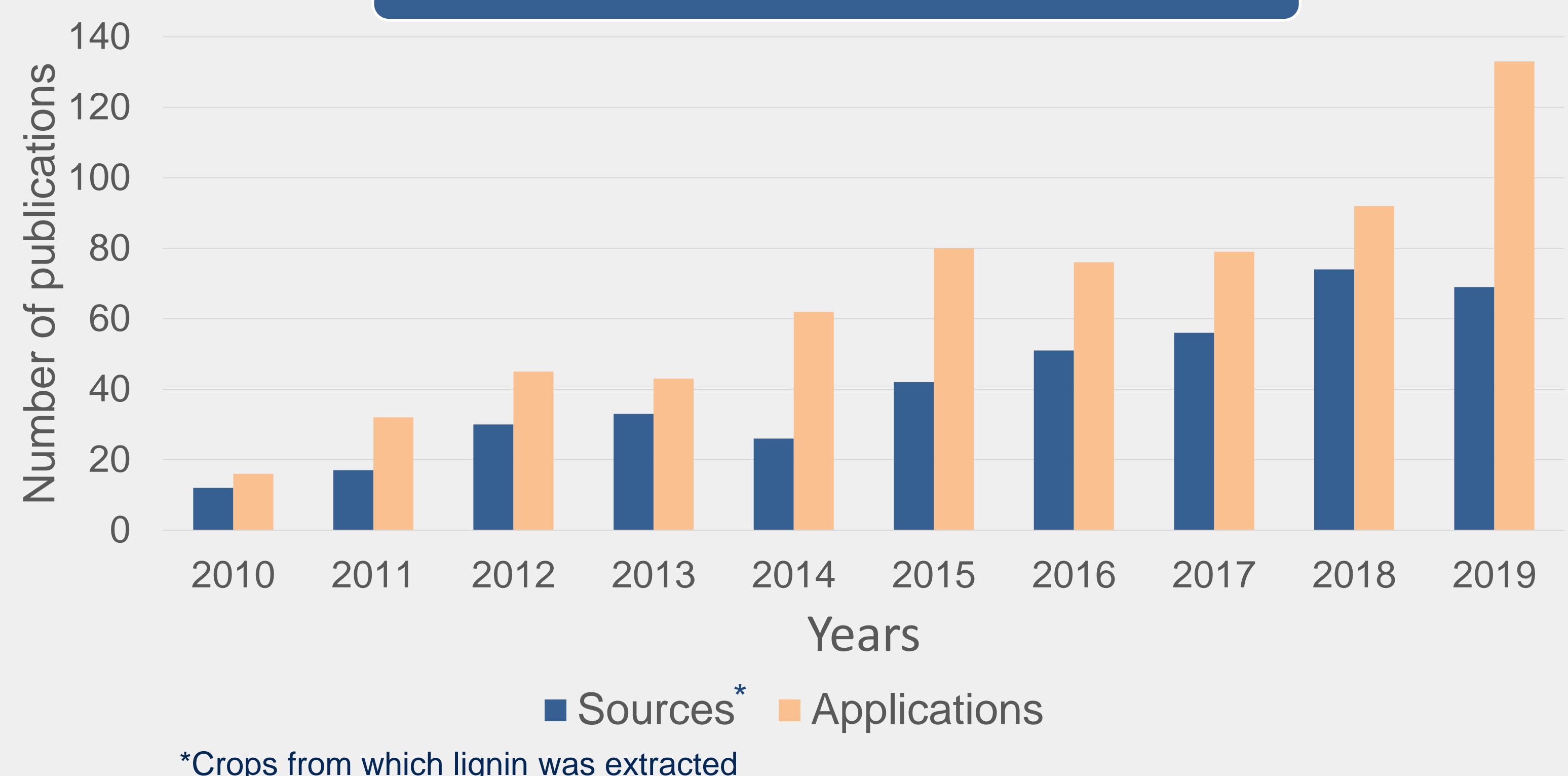
Sources

Crop	Ton/year	Publications
Sugarcane	1844869329	71
Maize	1028873145	81
Rice	744298942	68
Wheat	716457142	114
Soybean	334745339	3
Cassava	275202237	4
Sugar beet	266667754	3
Tomatoes	170469532	1
Barley	140120654	11
Banana	112227824	3
Apple	81291285	8
Cucumber	73502455	0
Grapes	73015259	11
Rapeseed	60912104	8
Coconuts	54832632	19
Sorghum	54646311	4
Groundnuts	44503906	5
Sunflower	43079067	2
Peppers	32759296	4
Millet	25678500	1
Peaches	22725873	3
Oats	20802686	2
Olive	19858517	26
Palm Kernels	15134855	5
Triticale	14801851	5
Rye	13737093	5

Applications

Application	Publications
Polymers	395
Antioxidant	165
Delivery	73
Antimicrobial	59
Bioremediation	43
Food	36
Surfactant	9
Dispersant	8
Fertilizer	4
Pesticide	3
Antidiabetic	2

Research Evolution



Conclusions

Due to the abundance of lignocellulosic biomass, there are several possible sources of lignin. That fact, combined with the complexity of lignin, translates into numerous potential applications. Research interest in agro-food lignin is noticeably increasing, either in sources or applications. The most used lignin extraction methods are alkaline and organosolv. Publications on applications of lignin use both agro and wood sources, nonetheless there is still a long way to close the circular economy cycle using agro sources and apply the extracted lignin in the agro-food industry.

References

¹Anwar, Z. et al. (2014) *J. Radiat. Res. Appl. Sci.* 7, 163–173; ²Bajwa et al. (2019) *Ind. Crops Prod.* 139, 111526; ³Yoo et al. (2020) *Bioresour. Technol.* 301, 122784

Acknowledgements

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