

# Assessment of the use and benefits of the Plantwise Knowledge Bank

## Authors

Mariam Kadzamira  
Adewale Ogunmodede  
Mariya Iqbal  
Frances Williams  
Simon Hill  
Claire Curry

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Mariam Kadzamira, CABI, Bakeham Lane, Englefield Green, Egham TW20 9TY, UK.  
Email: [M.Kadzamira@cabi.org](mailto:M.Kadzamira@cabi.org); ORCID: 0000-0003-3652-508X

Adewale Ogunmodede, CABI, Bakeham Lane, Englefield Green, Egham TW20 9TY, UK.  
Email: [A.Ogunmodede@cabi.org](mailto:A.Ogunmodede@cabi.org); ORCID: 0000-0001-6388-2870

Mariya Iqbal, CABI, Nosworthy Way, Wallingford, Oxfordshire, OX10 8DE, UK.  
Email: [M.Iqbal@cabi.org](mailto:M.Iqbal@cabi.org); . ORCID: 0000-0003-0405-8421

Frances Williams, CABI, Canary Bird, 673 Limuru Road, Muthaiga, PO Box 633-00621, Nairobi, Kenya.  
Email: [f.williams@cabi.org](mailto:f.williams@cabi.org); ORCID: 0000-0002-6772-0753

Simon Hill, CABI, Nosworthy Way, Wallingford, Oxfordshire, OX10 8DE, UK.  
Email: [s.hill@cabi.org](mailto:s.hill@cabi.org); ORCID: 0000-0002-5375-2818

Claire Curry, CABI, Nosworthy Way, Wallingford, Oxfordshire, OX10 8DE, UK.  
Email: [c.curry@cabi.org](mailto:c.curry@cabi.org); ORCID: 0000-0002-3997-3972

**Front page photo:** Ms Devika, a progressive farmer and plant doctor associated with the M.S. Swaminathan Research Foundation, consulting Plantwise Knowledge Bank content to support decision making at a plant clinic in Vilangudi, Tamil Nadu, India. Photo: Holly Ruffhead, CABI, with the permission of the subjects.

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## Abstract

This study assesses the use and benefits of the Plantwise Knowledge Bank (PWKB) using mixed methods. Focusing on website activity for 2021, study findings show that the PWKB has diverse users within national plant health ecosystems from both Plantwise and non-Plantwise countries. Plantwise countries are countries who have implemented elements of CABI's [Plantwise](#) programme. Most users in 2021 were from Plantwise countries in Asia, with users from other regions also contributing significantly to the site traffic. Furthermore, there was an increase in number of users, visits and page views as compared to past years, with the site having more men than women, visitors. Most users were repeat visitors who found the site organically via mobile phones. The site had very few referrals via social sites or paid searches, but there were fairly consistent referrals from Wikipedia ([https://en.m.wikipedia.org/wiki/Centre\\_for\\_Agriculture\\_and\\_Bioscience\\_International#Plantwise](https://en.m.wikipedia.org/wiki/Centre_for_Agriculture_and_Bioscience_International#Plantwise)). The top most searched and viewed content stayed relatively similar to past years, with the main use of information for research, identifying plant pests and diseases and for training/teaching. Examples of use show that the PWKB has real-life applicability and helps users to create solutions. Most survey respondents feel that the PWKB provides them with quick access to relevant information. In addition, it saves them searching many different websites and increases the quality of their work. Going forward, it is essential to continue site optimization for mobile users to ensure increased access by target users. There is also the need to prioritize the most searched sections on the homepage, thus making it easier for users to find what they are looking for. Suggestions from users for improving the site are provided.

## Acronyms and abbreviations

CABI	Centre for Agriculture and Bioscience International
CD-ROM	Compact Disc Read-Only Memory
DET	Digital Extension Tools
e-resource	Electronic Resource
GA	Google Analytics
HCD	Human-Centered Design
ICT	Information and Communication Technology
ISC	Invasive Species Compendium
KALRO	Kenya Agricultural and Livestock Research Organization
OPAC	Online Public Access Catalogue
PWKB	Plantwise Knowledge Bank

## Introduction

Oral communication is essential for people's interactions and societal function. The process of communication has evolved over time to include print and other forms such as computers, mobile phones, and associated gadgets, thanks to advances in science and technology (Kalbande *et al.*, 2012). Electronic resources (e-resources) are defined as "the resources that are generated by some electronic medium and made available to a large range of viewers both on-site and off-site via some electronic transferring equipment or the internet" (Saye, 2001). E-books, e-journals, web-based resources, e-databases, data archives, manuscripts, maps, magazines, theses, newspapers, e-mail, research reports and online catalogues are all examples of e-resources (Sharma, 2009; Quadri, 2012).

The core of e-resources is information and communication technology (ICT), which has transformed how information is produced, processed, saved and transmitted and how users seek and access information (Anunobi and Okoye, 2008; Chandel and Saikia, 2012). In the agricultural sector, ICTs have facilitated relationships between researchers, extension workers and farmers (Richardson, 1996), by making it easier to access information for better decision making. Agricultural researchers benefit from ICTs via improved access to information required for conducting research and as a platform for disseminating research findings. Agricultural extensionists utilize ICTs to communicate practical issues to research institutes and other key stakeholders involved in the agricultural extension system, and use the same tools for accessing information and resources for onward sharing with farmers. There are several ways for people to access e-resources. These include Online Public Access Catalogue (OPAC), search engines and websites (Bhatia and Rao, 2012). Electronic journals, online databases and Compact Disc Read-Only Memory (CD-ROM) databases are some of the many forms of e-resources. Open access or subscription-based repositories provide information to the public.

### Benefits of e-resources

E-resources are often faster than examining print indexes, especially when searching retrospectively, and they are more straightforward when intending to employ keyword combinations. They make it possible to search many files at once, which is much easier to do than with printed counterparts. E-resources can be printed, and searches can be stored for later use; and they are updated more frequently than printed materials (Singh and Bebi, 2012). E-resources offer various benefits to users, including convenience in terms of time and location, timeliness, the capacity to search directly through text, the ability to link to other reading material and the ability to distribute and share information (Quadri, 2012).

Sharing information is critical for developing new knowledge required for socioeconomic growth. Several studies have found elements that influence how people use e-resources. These include training modalities, awareness, influencers, utilitarian benefits, and experiential and hedonic benefits (Kumar and Kumar, 2010; Sawang *et al.*, 2013; Garg *et al.*, 2017). The budget for acquiring devices to access these resources, such as computers and subscriptions paid to the publisher for access to a resource, can also influence the accessibility and use of e-resources (Martin, 2010). People utilize e-resources for communication, professional development and associated jobs, supporting teaching and administrative work, personal use, research activities and recreation (Renwick, 2005). In various countries, e-resources have proven to be beneficial to agriculture. Agricultural researchers value the relevance of e-resources in their everyday work since updated knowledge is necessary for successful agricultural research (Angello and Wema, 2016). E-resources have also proven to be a good source of

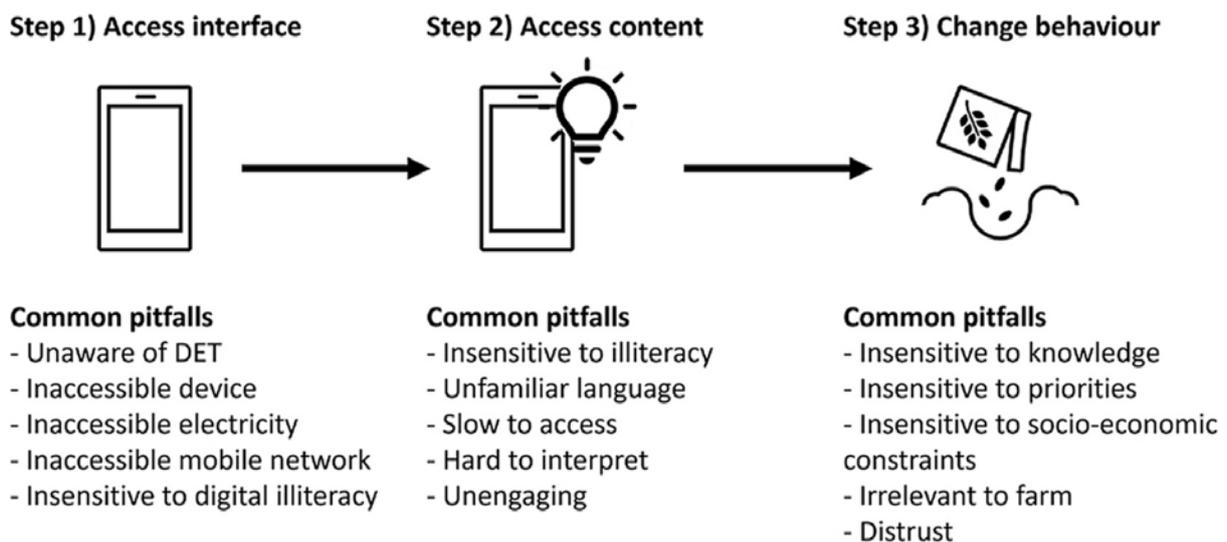
crop and animal husbandry knowledge (Thanuskodi, 2010; Singh and Bebi, 2012). They also connect agricultural research and extension even though agricultural research institutes are isolated and far from farms (Coulson and Diyamett, 2012).

## Challenges with e-resource usage and uptake

Despite the great potential of e-resources, evidence indicates that users' utilisation of common agricultural e-resources is still low, probably due to a lack of understanding (Mtega *et al.*, 2015; Angello and Wema, 2016). Challenges to e-resource usage cut across the broad spectrum of users in the agricultural sector. This is the case despite advances in technology and the continuous incorporation of user experiences. This is in part due to pre-existing bottlenecks in many developing countries which hinder effective update and usage of e-resources. These include but are not limited to low (digital) literacy levels (Thies, 2015) as well as poor infrastructure and limited internet connectivity (World Bank, 2021). Above all this is the wide diversity of users, their changing needs and contexts, which creates dynamic challenges (Maumbe and Okello, 2010).

Emerging evidence continues to show that the challenges of agricultural e-resource usage and uptake in the developing world are multi-faceted. For example, Coggins *et al.* (2022) found that there are fifteen different factors constraining smallholder farmer's use of Digital Extension Tools (DET) (Fig. 1) in sub-Saharan Africa, South Asia and Southeast Asia in terms of:

- Interface access: accessing the digital platform that supports the DET
- Content access: accessing or exchanging information or knowledge within the DET
- Behaviour change: acting differently as a result of using the DET.

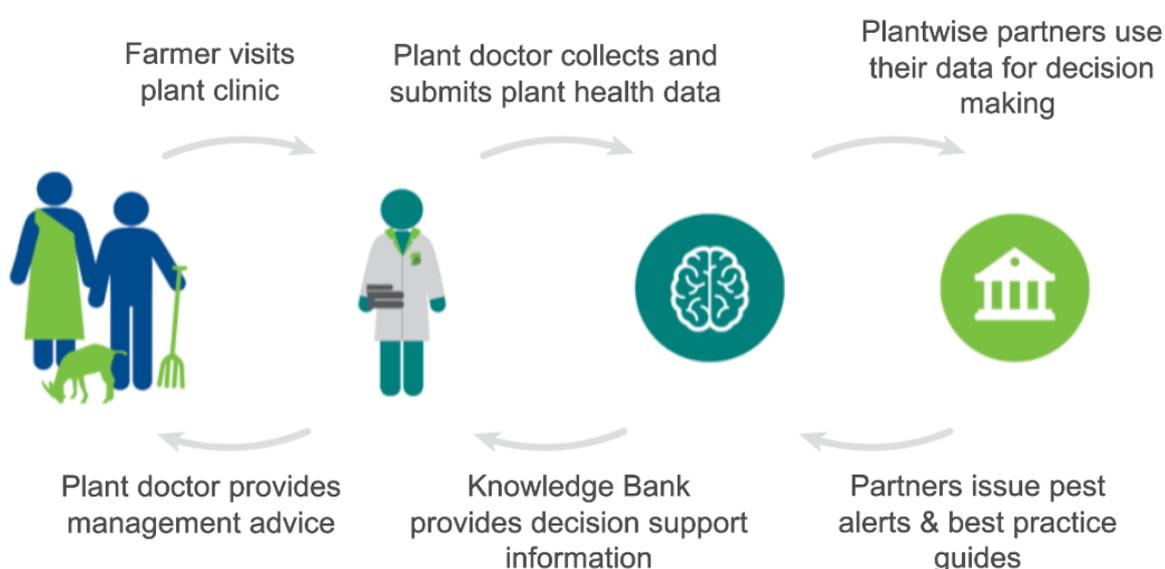


**Fig. 1.** Challenges of Digital Extension Tools (DET). Source: Coggins et al. (2022).

Given these complexities, it is essential for e-resources, including those in the agriculture sector, to conduct assessments to inform regular improvements, thus ensuring relevance.

## Study justification

The Plantwise Knowledge Bank (PWKB) is an example of an e-resource. Launched in 2012 under the Plantwise programme, it was established to serve diverse plant health stakeholders in the developing world, as a central information resource for crop protection (Leach and Hobbs, 2013). This is achieved by collecting, analysing and disseminating pest data in order to enable: i) identification and management of plant pests; ii) protection against pest and disease threats; and iii) secure storage and analysis of national plant pest data (Iqbal, 2021). Provided free of charge, thanks to support from the Plantwise and now the PlantwisePlus programme, the PWKB is an online resource that gathers plant health information from across the world. It has over 15,000 pieces of content, which include: pest management decision guides, factsheets for farmers, species pages, photosheets, manuals and video factsheets in over 100 languages (Iqbal, 2021). The PWKB also provides users with really useful tools including a diagnostic tool, country resources, pest alerts, interactive maps and a booklet builder. The site is also mobile responsive which enables smartphone users in various countries to access the site with ease (Iqbal, 2021) (Fig. 2).



**Fig. 2.** The Knowledge Bank information flow. Source: CABI

The PWKB links all actors in the plant health system (plant clinics, researchers, extension workers, farmers and government bodies) to the information they need for timely action against crop pests and diseases (Iqbal, 2021). Since its establishment, the PWKB has undergone regular testing and adapting of tools and content with key stakeholders, and as such, it is now able to provide relevant, actionable plant health information in the appropriate format, meeting global quality standards (Cameron *et al.*, 2016). This is key as stakeholder needs are ever evolving and this necessitates regular assessments, usability testing and market research to improve the site and its functionality. Such assessments ensure that the PWKB is able to continue to support the diverse needs of key stakeholders and help strengthen developing country plant health systems (Leach and Hobbs, 2013). This study is one such assessment and it aims to contribute by providing an in-depth look at the use and benefits of the PWKB and investigate how information and data informs the work of users.

## Approach

To meet the study objectives, insights are drawn from Google Analytics (GA) from PWKB for the 2021 calendar year and from survey responses from a Hotjar survey which was launched on the PWKB in November 2021. This section provides a review of some methods which have been used to understand the use and benefits of e-resources, and provides justification for selection of the approach that has been utilized in this study.

### Google Analytics

Web analytics involve the collection, measurement, monitoring, analysis and reporting of web usage data to understand user experiences and their behaviour (Hasan *et al.*, 2009; Barba *et al.*, 2013). Analytics can help to optimize websites in order to accomplish business goals and/or to improve customer satisfaction and loyalty (Hasan *et al.*, 2009). Web analytics can provide insight for improving a website's content, navigation, accessibility and design (Ledford *et al.*, 2010).

In this study the Google Analytics from the PWKB for the 2021 calendar year are analysed in order to understand and improve user experience. These were collected via web traffic data using client based page-tagging. The page-tagging approach involves adding a few lines of script to the pages of a website to gather statistics from them (Hasan *et al.*, 2009). The data are collected when the pages load in the visitor's browser as the page tags are executed (Hasan *et al.*, 2009). This approach was employed as various studies (Fang, 2007; Prom, 2007; Hasan *et al.*, 2009; Plaza, 2011; Barba *et al.*, 2013; Onyango *et al.* 2016) have demonstrated that Google Analytics are a powerful tool, as they provide reports for quickly identifying problems and determining if a website provides the necessary information that users require. In addition, they are cost effective and they aid in the collection of two categories of data:

- User acquisition data: i) user demographic characteristics such as age, gender, interests; and ii) user acquisition channel data (referrals, organic, paid).
- User behaviour data: behaviour of the website users (i.e. landing page data, average session duration data).

### Hotjar survey

Many web analytic studies including those using Google Analytics recommend that web metrics need to be augmented by further investigation involving actual users of a website. This is because user-provided evidence provides priceless information about the actual benefits and uses of any e-resource (Barba *et al.*, 2013) which can be used for improvements to better align with user needs and contexts. We used a Hotjar survey, which is an on-site survey. Hotjar surveys have gained popularity and have been used by experts to evaluate the use of e-resources. An example is the study by Williams *et al.* (2021) to assess the use and benefits of the Invasive Species Compendium (ISC).

The Hotjar survey (see Annex 1) for this study was launched on 1st November 2021 and was live for one month. Visitors to the PWKB during this time self-selected to respond to the survey. The survey captured information pertaining to how the PWKB is used and what benefits it brings to its users. This included collecting the following information from respondents: their main occupation, how the PWKB information helps with their work and what the information is used for, an example of how information has been used in practice, their gender and any suggestions for improving the PWKB.

## Insights from Google Analytics – 2021 overview

This section provides the insights from the Google Analytics for 2021. The data excludes CABI users.

### Users and site visits

In 2021 the PWKB had 394,314 visits from 293,262 users (Fig. 3). This shows that some of these were repeat visitors. Compared to 2020, there was an increase in both the number of users and visits to the site, with 2021 having 34% more users and 35% more visits. Figure 3 further shows that visits and usage were relatively constant over 2021, although early in the year and mid-year there were spikes in both users and visits. In addition, in 2021 there were 573,651 page views; this is an increase of 26% as compared to 2020, which had 455,557 page views.

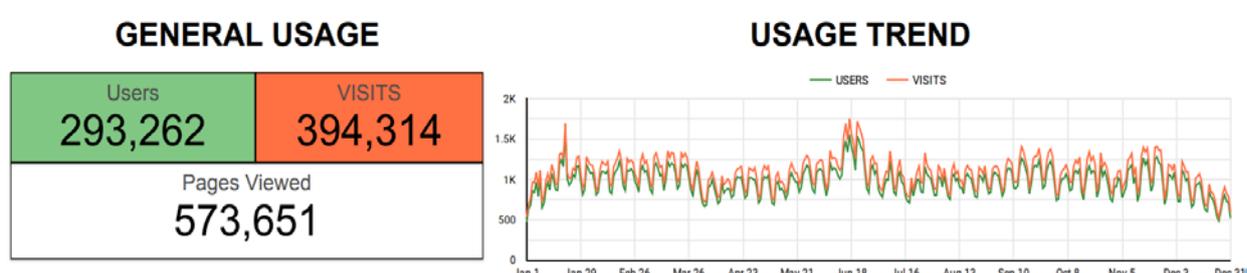


Fig. 3a. PWKB usage and site visits - 2021

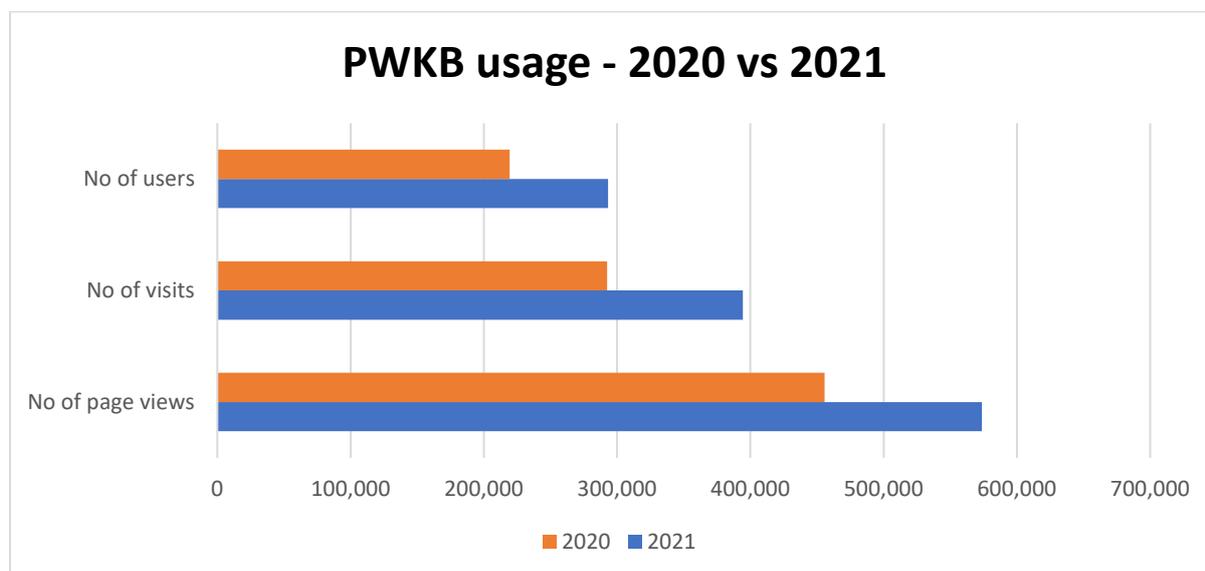


Fig. 3b. PWKB usage and site visits – 2020 vs 2021. Source: CABI analytics dashboard

### Country of users

The PWKB attracts users from both Plantwise and non-Plantwise countries (Fig. 4). Plantwise countries are countries who have implemented elements of the Plantwise programme<sup>1</sup>. Plantwise country users were more likely to visit the site more than once and they viewed more pages than non-Plantwise

<sup>1</sup> CABI's Plantwise programme has been introduced in 34 countries since 2011 in Africa, Asia and the Americas. See <https://www.plantwise.org/impact/plantwise/> for more information.

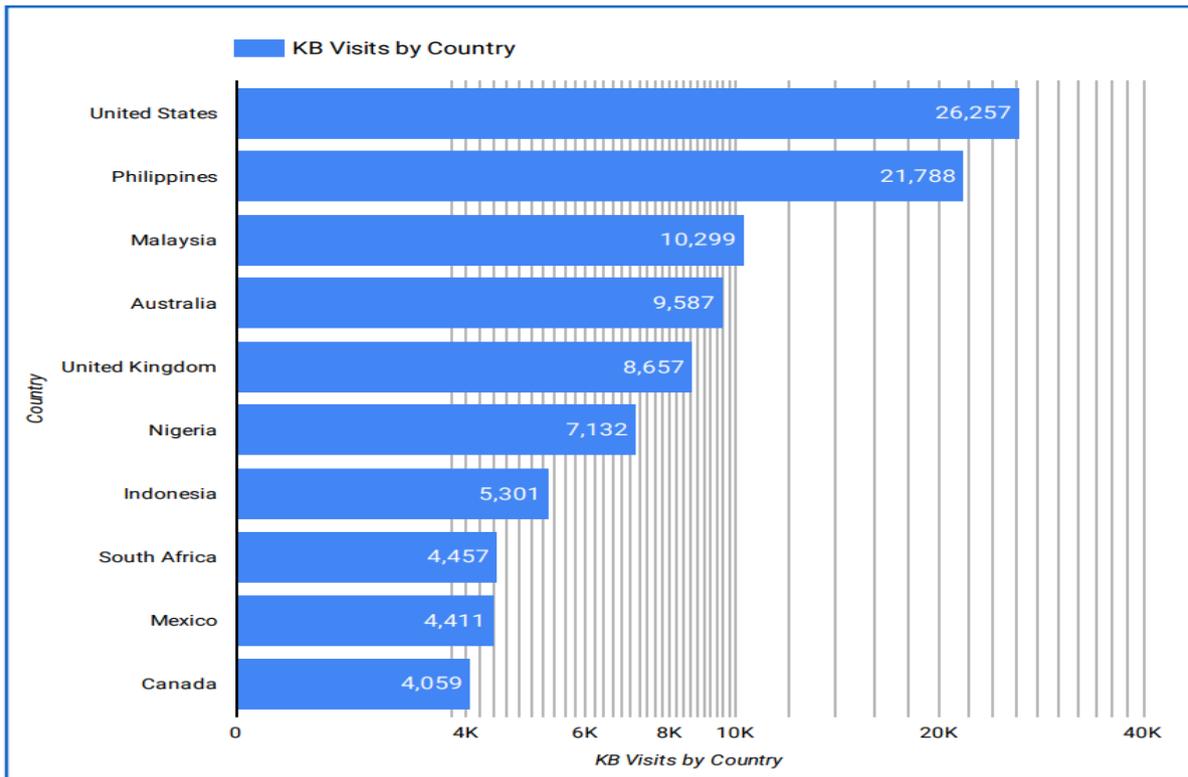
users. Nevertheless, non-Plantwise country users accounted for 44.7% of all visits to the site and just over 47% of all pages viewed.



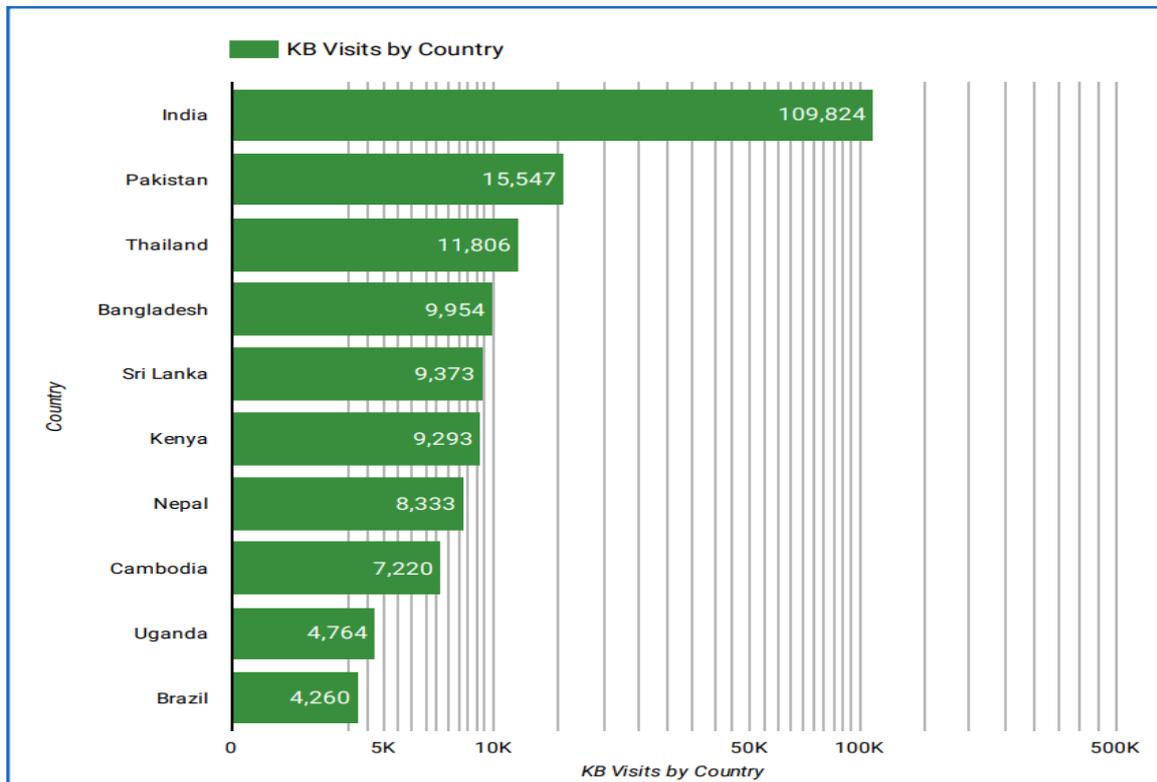
**Fig. 4.** Users and visits 2021 – non-Plantwise vs Plantwise countries. Source: CABI analytics dashboard. Note: total users and page visits differ from Fig. 3 as Fig. 4 only takes into account filtering for Plantwise and non-Plantwise users and visits. Figure 3 is the total numbers for the website based on Google Analytics capture.

In terms of the country of the user, we find that seven of the top ten Plantwise countries with the most site visits in 2021 are from Asia (Fig. 5b). The rest are from East Africa (Kenya and Uganda) and South America with Brazil as the 10<sup>th</sup> country with the most visits to the site in 2021. Overall, the five Plantwise countries with the most visits to the site in 2021 were: India, Pakistan, Thailand, Bangladesh and Sri Lanka. Figure 5a also shows that for non-Plantwise countries, there was a mix of countries from various continents with the top ten countries comprising three countries each from Asia (Philippines, Malaysia and Indonesia) and North America (USA, Mexico and Canada) and two countries from Africa (Nigeria and South Africa). The rest were from Europe and Australia.

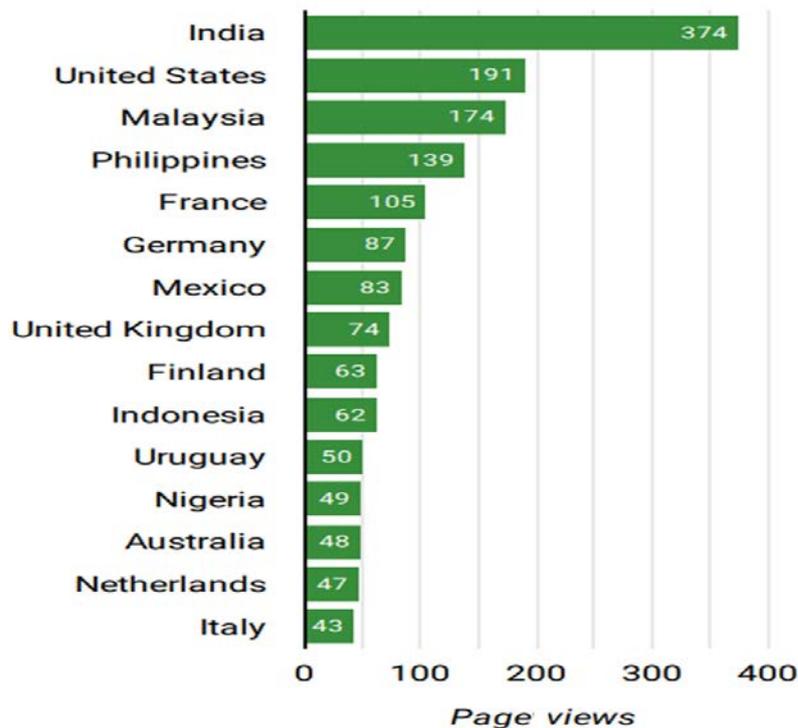
Overall, Fig. 6 shows that India accounted for the greatest number of page views in 2021. After India, there are fourteen other countries that contributed the most to page views in 2021. These countries are spread across the globe with countries from the Americas, Asia, Europe and Africa. This shows that the PWKB is used widely by users in both Plantwise and non-Plantwise countries – in both developing and developed countries.



**Fig. 5a.** Visits in 2021 to the PWKB by country – non-Plantwise Countries



**Fig. 5b.** Visits in 2021 to the PWKB by country – Plantwise Countries only. Source: CABI analytics dashboard.



**Fig. 6.** Page views by country, 2021. Source: CABI analytics dashboard.

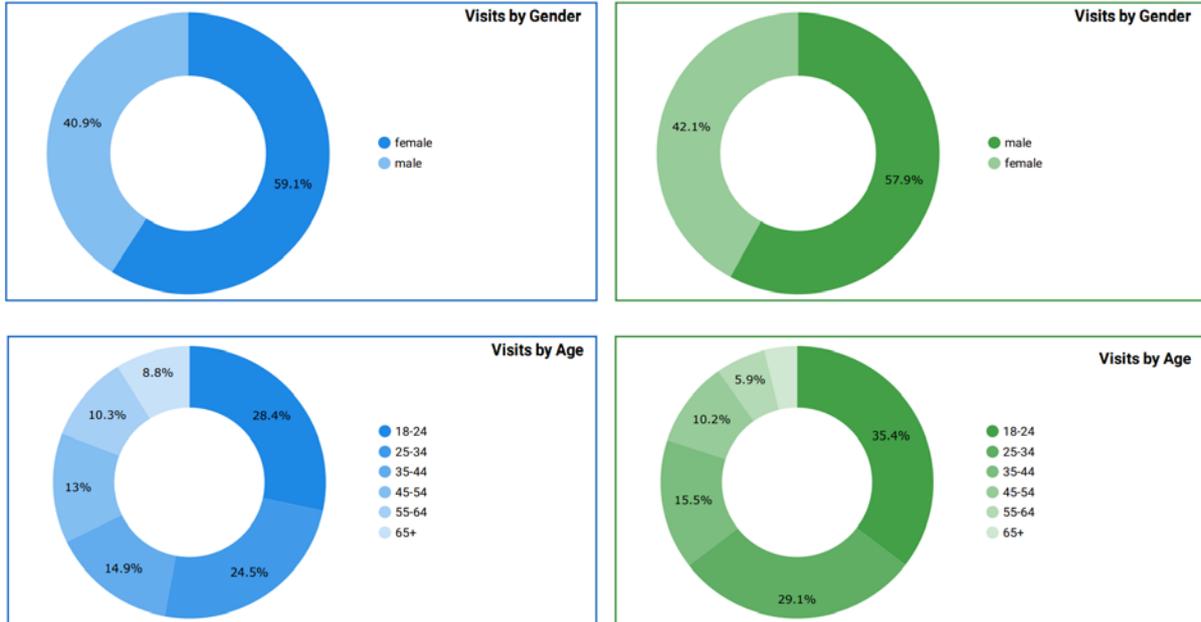
### Demographics of users

In 2021 almost 60% of all users from Plantwise countries were men. In contrast in the non-Plantwise countries most users were women (59.1%). The finding from the Plantwise countries is not surprising as recent sector reports show that most users of the internet, smartphones and e-resources in the developing world are currently men, with women lagging behind (UNCTAD, 2019: page 14; Iglesias, 2020; GSMA, 2021). This is due to the prevailing gender digital divide in most developing countries (GSMA, 2019; UNCTAD, 2019: page 14). The gender digital divide is perpetuated by various factors including gendered differences in income, time availability, literacy levels and education, language, attitudes and knowledge of information technology ( Bassi and Camble, 2011; Funmilayo, 2013; World Wide Web Foundation, 2015; Teklemariam, 2020) and household gender roles which affect internet use patterns (Thanuskodi, 2012).

In terms of age, the youth aged between 18 and 24 years made up the largest sub-set of users for both Plantwise (35.4%) and non-Plantwise countries (28.4%) in 2021. These are followed closely by those aged between 25 and 34 who make up 29.1% and 24.5% of all users from Plantwise and non-Plantwise countries, respectively (Fig. 7). These findings agree with the existing evidence that globally, the lives of the youth are increasingly shaped by digital technologies (Lombana-Bermudez *et al.*, 2020). This is the case with 71% of all youth aged between 15 and 24 years in the world in 2020, using the internet, as compared to only 57% of all other age groups (ITU, 2021). Although regional disparities exist, with the youth in developed countries having greater access and engagement with digital technologies (ITU, 2017; 2021), evidence shows that within the developing world, the youth are at the forefront in terms of the uptake of ICTs and usage of the internet (ITU, 2017; 2021).

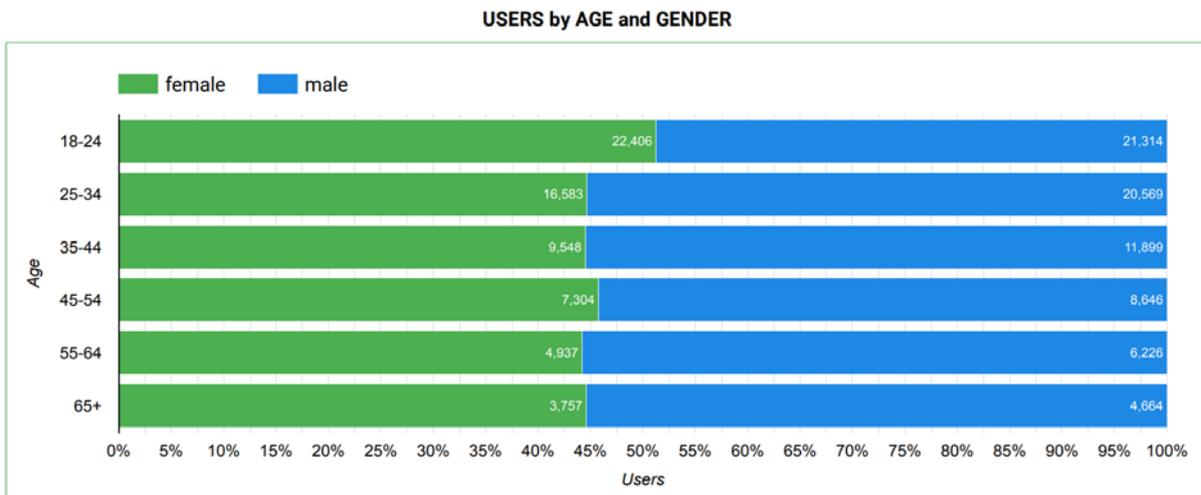
## NON-PLANTWISE COUNTRIES

## PLANTWISE COUNTRIES



**Fig. 7.** Visits to the PWKB by gender and age, 2021. Source: CABI analytics dashboard.

Among the various age groups that used the PWKB in 2021, we find that the gender divide prevails except amongst the youngest users, with more young women (22,406) aged 18 to 24 than men (21,314) using the site (Fig. 8). Although this finding is not aligned to the general statistics which show that in two-thirds of the world, there is generally more men than women using the internet (ITU, 2017), it is a picture of emerging trends.



**Fig. 8.** Gender of users of the PWKB by age group, 2021. Source: CABI analytics dashboard.

## Access

The majority of users from Plantwise countries (67%) accessed the PWKB via mobile devices (Fig. 9). This agrees with data that shows that mobile internet is more popular than desktop in most countries

that are in the developing world – this is the case in Africa,<sup>2</sup> Asia<sup>3</sup> and to some extent in South America.<sup>4</sup> On the contrary, the majority of users from non-Plantwise countries (59.%) accessed the PWKB via desktop computers. This aligns with emerging usage statistics for regions including non-Plantwise countries which show that although mobile internet is very popular, slightly more people access the internet via desktop than mobile – this is the case for North America<sup>5</sup> and Europe.<sup>6</sup>

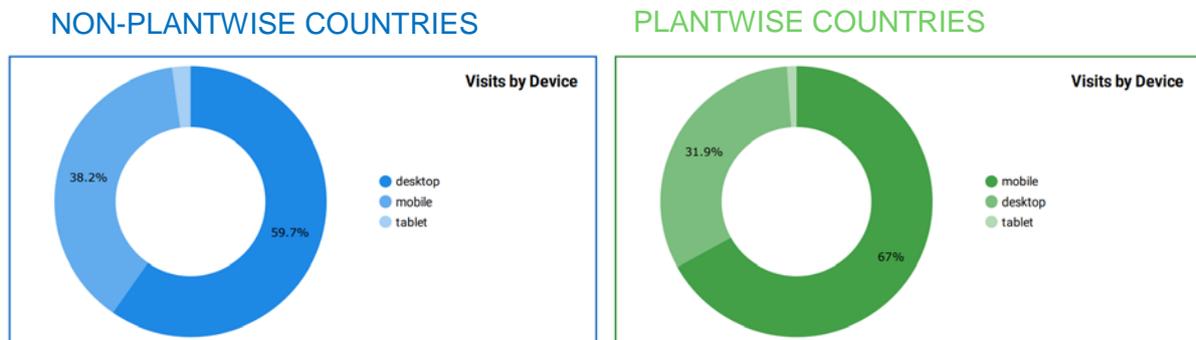


Fig. 9. Visits by device, 2021. Source: CABI analytics dashboard.

### How they found the PWKB

Most users found the PWKB via an organic search (78.2%). So, users are aware of the PWKB and have used a search engine to find it. The visits from paid searches (5.4%) were lower than previous years, but only slightly. This indicates that the platforms and social sites being used need to be further explored to take advantage of this space and reach a greater target audience. Other channels via which users found the PWKB are varied and included referrals from Facebook, Bing, Wikipedia, Celkai and CABI websites (Fig. 10).

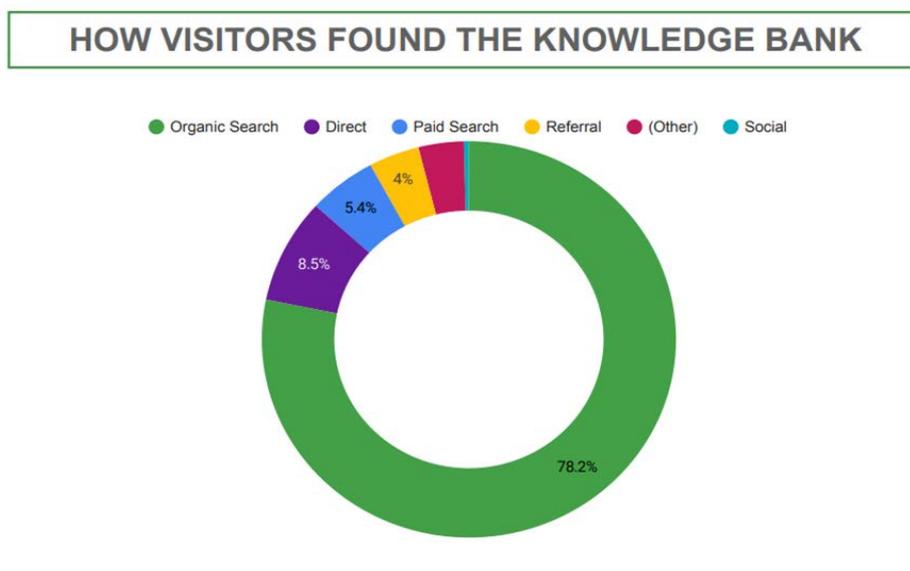


Fig. 10. How visitors found the PWKB, 2021. Source: CABI analytics dashboard.

<sup>2</sup> <https://gs.statcounter.com/platform-market-share/desktop-mobile-tablet/africa>

<sup>3</sup> <https://gs.statcounter.com/platform-market-share/desktop-mobile-tablet/asia>

<sup>4</sup> <https://gs.statcounter.com/platform-market-share/desktop-mobile-tablet/south-america>

<sup>5</sup> <https://gs.statcounter.com/platform-market-share/desktop-mobile-tablet/north-america>

<sup>6</sup> <https://gs.statcounter.com/platform-market-share/desktop-mobile-tablet/europe>

## Content

The most searched term in the Plantwise Knowledge bank was the asterisk symbol (\*); this allows the user to see all the content in the search library. There were some improvements made on the site's homepage in September 2021, a new 'Search all' button was added next to the search bar to help users navigate to the content library. The data supports the successful addition of this button. Throughout the year, the top 10 most searched for terms stayed relatively similar, including 'fall armyworm', 'maize', and 'pest management decision guide' (Fig. 11). The most searched for terms often align with the most viewed content.

KEYWORD SEARCHES ON THE KNOWLEDGE BANK	
Search Term	Total Searches
*	463
maize	165
"pest management decision guide"	152
Photoguide	130
Hemileia vastatrix	122
cocoa photoguide	105
fall armyworm	105
rice	103
wheat	103
Spodoptera exigua	102

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**Fig. 11.** Keyword searches on the PWKB, 2021. Source: CABI analytics dashboard.

From user flow journeys of the PWKB, it is clear that most of the users are dropping off after landing on their starting page (Fig. 12). This is the case whether they are landing on a datasheet, factsheet or a Pest Management Decision Guide. This may mean they were able to get what they needed from the factsheet, which is great, but this is unknown unless we are able to engage with our end-users. This may be something to investigate in the future. Users that stay on the site generally return to the search page to explore other factsheets, as evidenced by the activity on the 1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> interactions (Fig. 12).

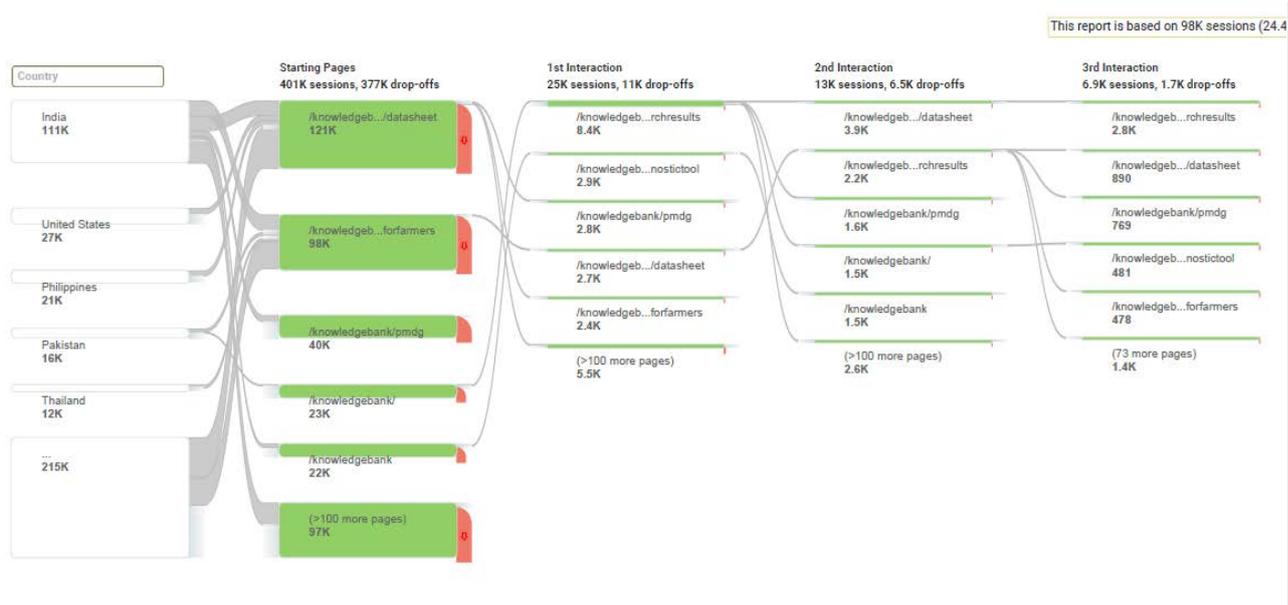


Fig. 12. User flow for the PWKB by country, 2021. Source: Google Analytics.

## Wikipedia

This data is captured from Wikipedia<sup>7</sup> redirects (referrals) to the PWKB (Fig. 13). There was a fairly consistent number of visits from this channel with a couple of significant spikes in April and December. These spikes were associated with a datasheet on *Dysdercus cingulatus*, which had the highest number of landing pages from the Wikipedia traffic in 2021. The highest number of visits were from India (374), followed by United States (191) and Malaysia (174). Interestingly, this data is an excellent way of seeing what species are being searched for within a country at a set time, which could reflect a new pest outbreak, driving the content added to the PWKB.

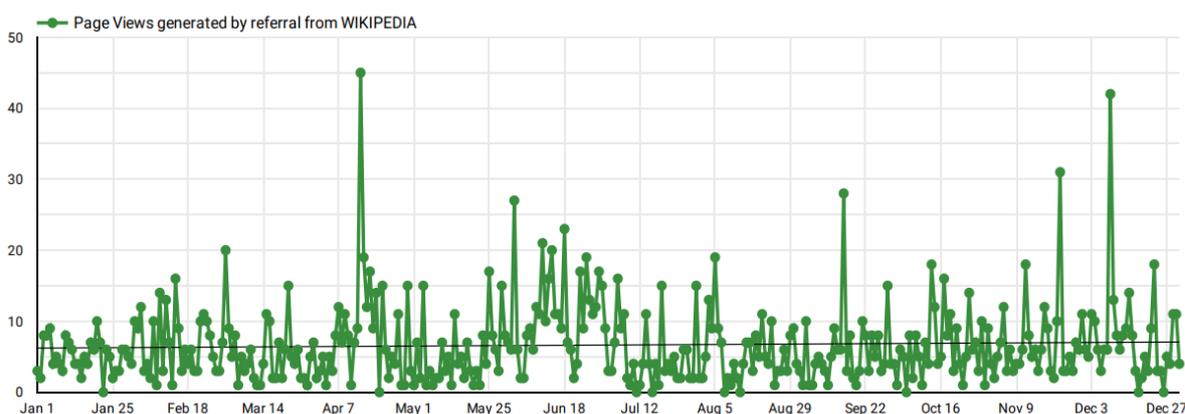


Fig. 13. Page views generated by referral from Wikipedia in 2021.. Source: CABI analytics dashboard.

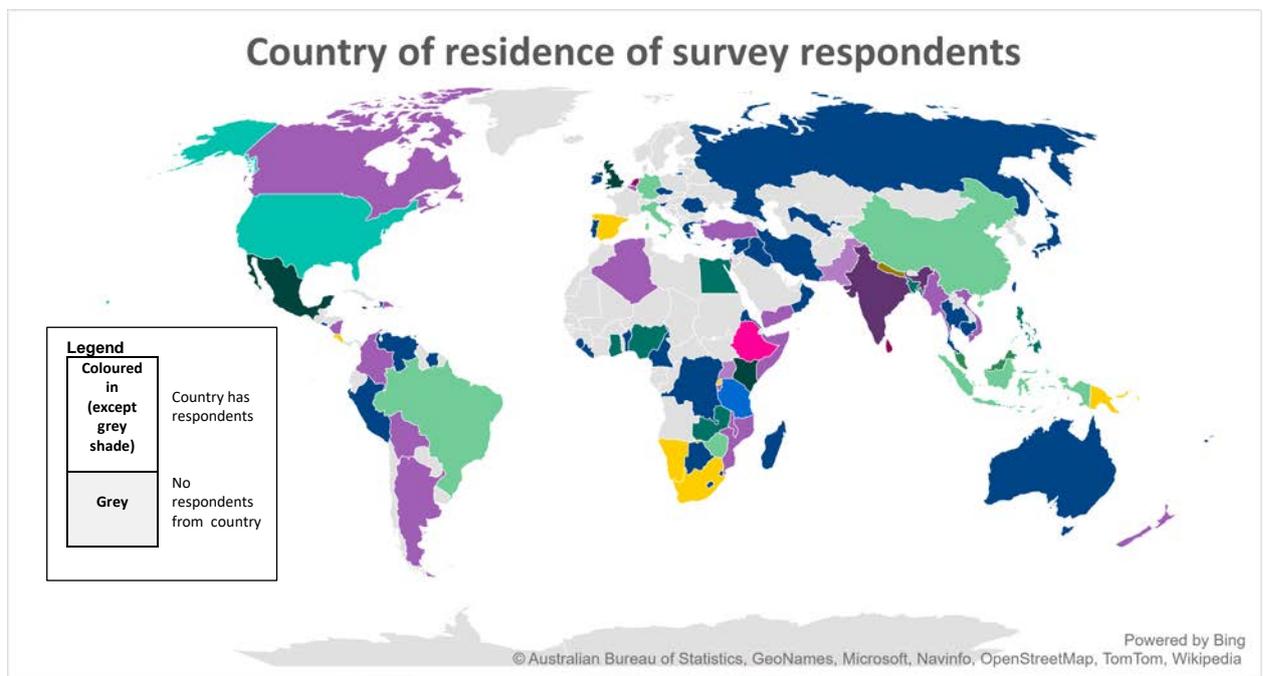
<sup>7</sup> [https://en.m.wikipedia.org/wiki/Centre\\_for\\_Agriculture\\_and\\_Bioscience\\_International#Plantwise](https://en.m.wikipedia.org/wiki/Centre_for_Agriculture_and_Bioscience_International#Plantwise)

## Survey results

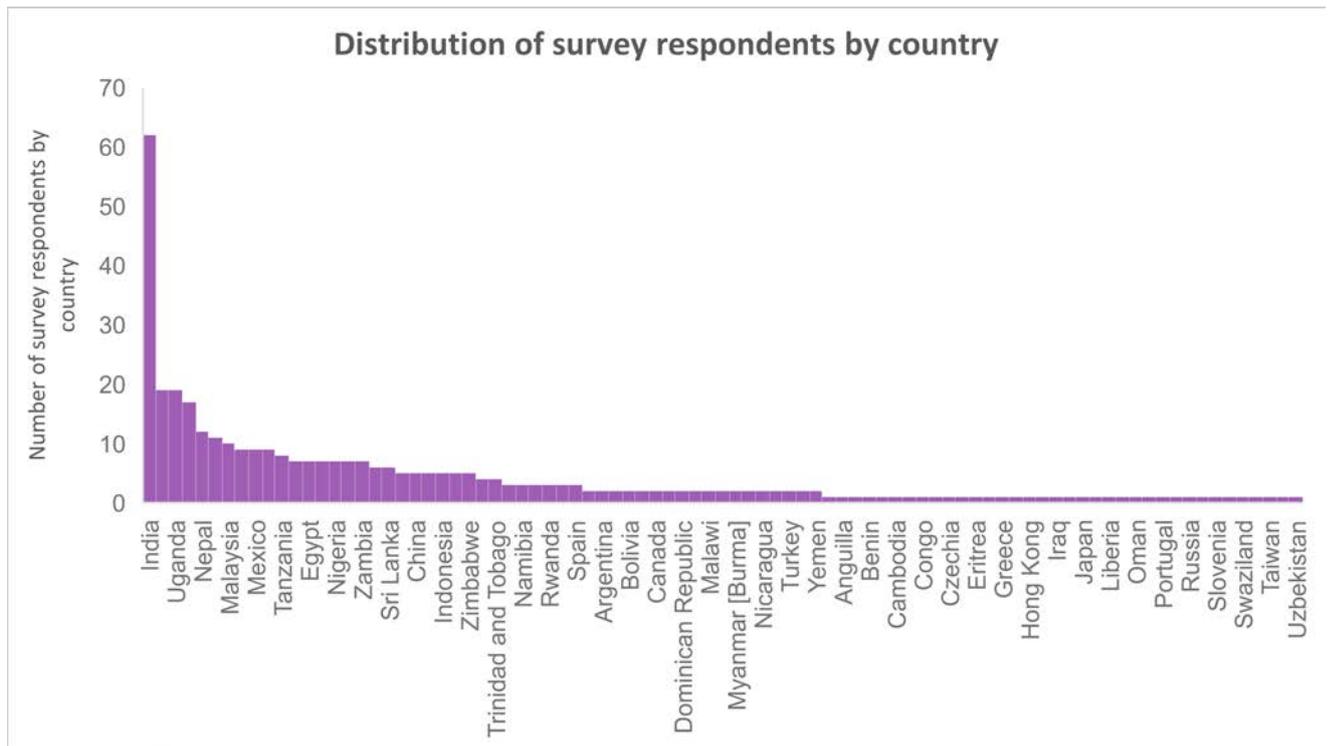
As stated earlier a Hotjar survey was launched in order to complement the insights from the Google Analytics to better capture user experiences. The sections that follow provide the findings from the Hotjar survey.

### Geographical location of survey respondents

A total of 369 people, from 88 different countries responded to the survey (Figs 14 and 15). Countries with the greatest number of respondents were India (62, 16.8%), Pakistan (19, 5.2%), Uganda (19, 5.2%), United States of America (USA) (17, 4.6%), Nepal (12, 3.3%) Ethiopia (11, 3.0%) and Malaysia (10, 2.7%). This trend aligns with the insights from the Google Analytics with all but Ethiopia being amongst the top ten countries with the highest number of visits to the PWKB in 2021 (See Figs 5a and b).

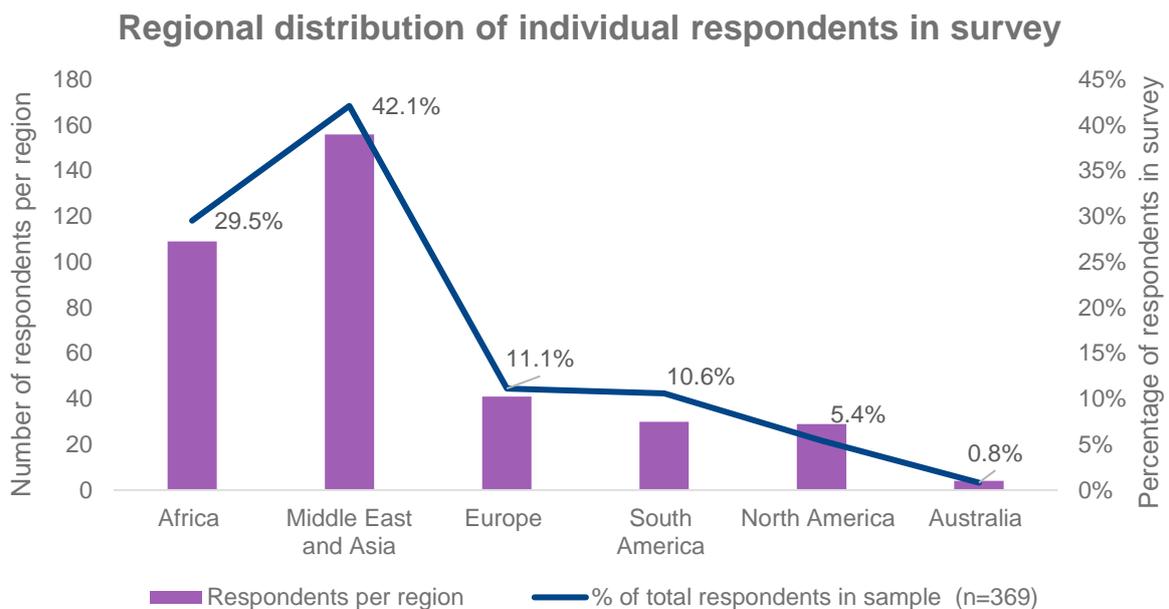


**Fig. 14.** Map - geographical location of survey respondents. Source: authors' compilation from PWKB survey data.



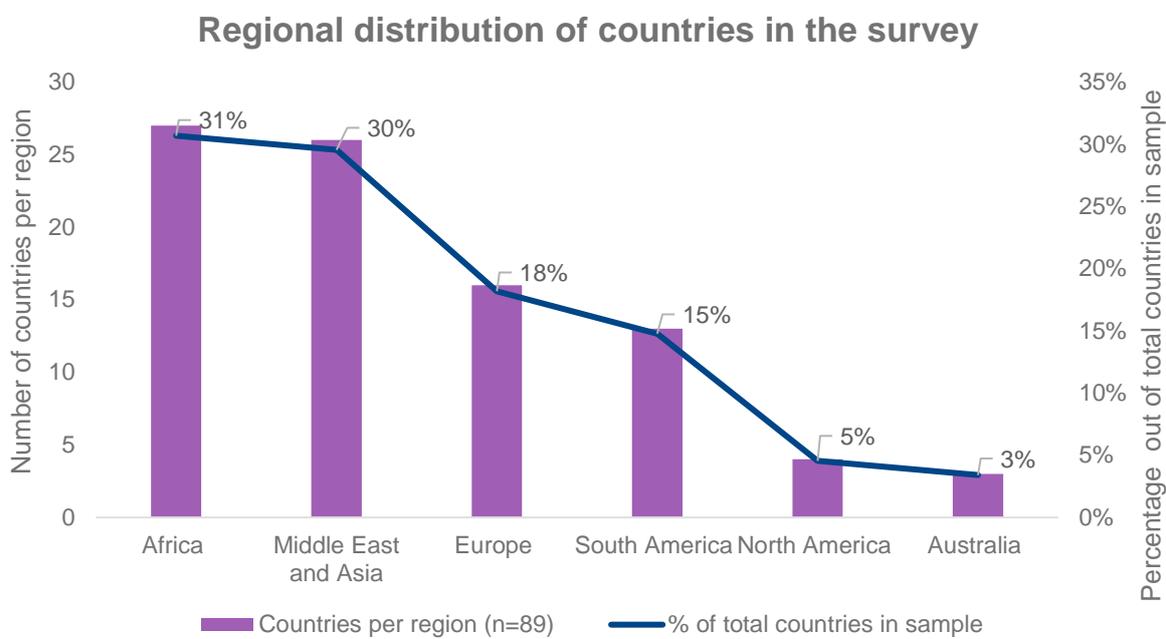
**Fig. 15.** Distribution of survey respondents by country. Source: authors' compilation from PWKB survey data.

The Middle East and Asia had the greatest number of respondents as a region, with 155 respondents, making up 42.1% of all survey respondents (Fig. 16). Africa had 109 respondents, accounting for 29.5% of all survey respondents. Europe on the other hand had 41 respondents, accounting for 11.1% of all survey respondents.



**Fig. 16.** Regional distribution of the country of survey respondents. Source: authors' compilation from PWKB survey data.

In terms of number of countries per region, Africa had the greatest number of different countries responding to the survey, with respondents from 27 different countries, accounting for 31% of all the countries where respondents come from. On the other hand, countries in the Middle East and Asia and Europe accounted for 30% and 18% of all countries where survey respondents are based, respectively (Fig. 17).



**Fig. 17.** Regional distribution of survey respondents. Source: authors’ compilation from PWKB survey data.

### Gender of survey respondents

Most of the survey respondents did not provide their gender. However, amongst those who did, the majority are men (18.2%) and a small proportion are women (8.4%) (Fig. 18). This trend is reflected in Africa, Middle East and Asia and Europe, with most respondents (amongst those providing their gender) being men (Fig. 19). This finding is in line with other studies that show that surveys on e-resources in Africa have higher response rates from men than from women (Bassi and Camble, 2011). In Asia, recent studies show that although the continent is one of the most digitally advanced, there is still a clear mobile gender divide (GSMA, 2019). For example in South Asia, women are 28% less likely than men to own a mobile phone and 58% less likely to use mobile internet (GSMA, 2019). Mobile phones are the primary means of accessing the internet in low-and-middle income countries (GSMA, 2019), hence the mobile gender gap makes it less likely for women to utilize e-resources or respond to surveys that require internet use.

### Gender of survey respondents

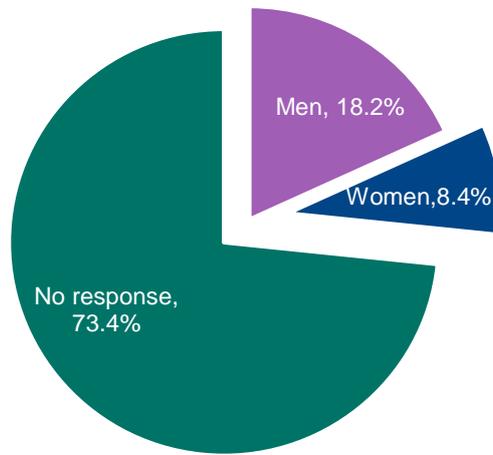


Fig. 18. Gender of survey respondents. Source: authors' compilation from PWKB survey data

### Gender of survey respondents by region

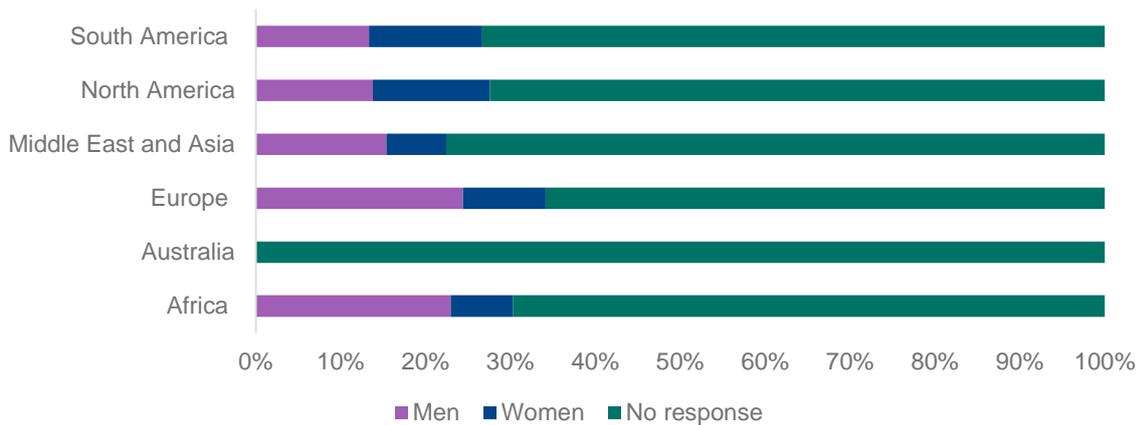
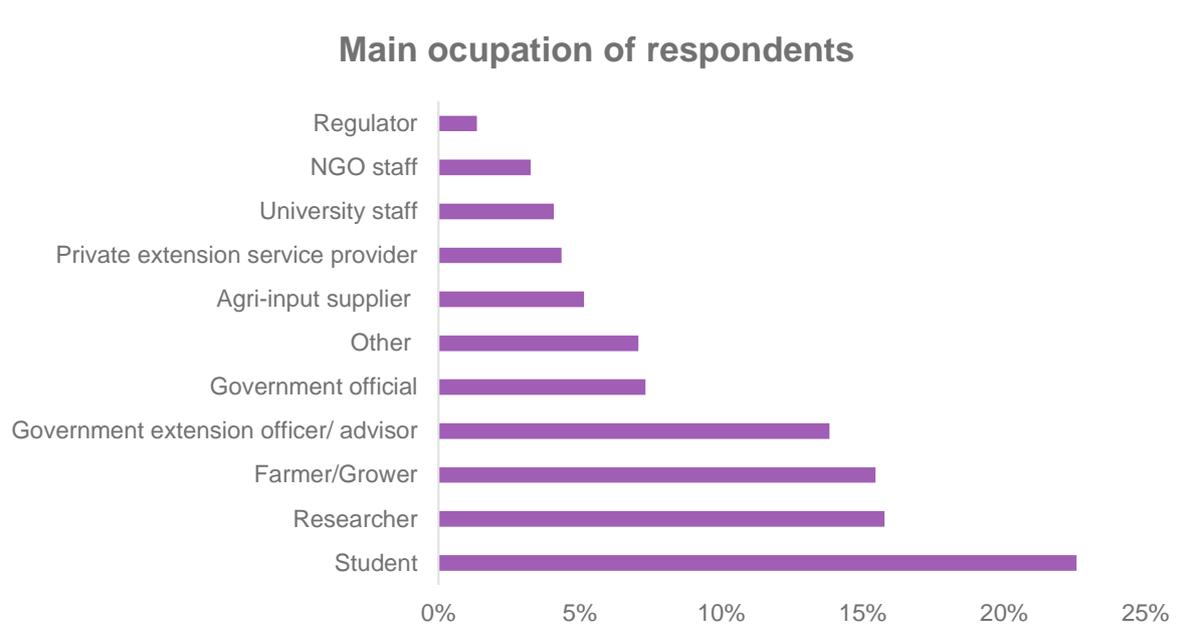


Fig. 19. Gender of survey respondents by region. Source: author compilation from PWKB survey data.

### Main occupation of respondents

Most survey respondents are students (23%), researchers (16%), farmers/growers (15%) or government extension officers/advisors (14%) (Fig. 20). In addition, just under 10% of survey respondents are either government officials or are engaged in other occupations.

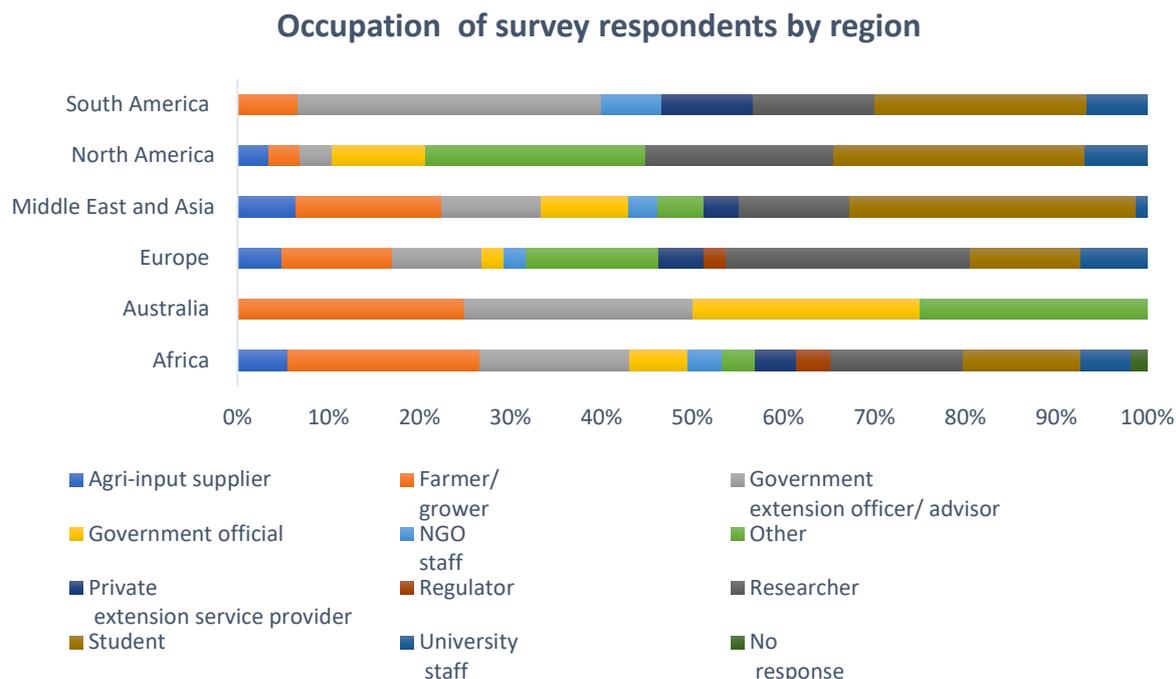


**Fig. 20.** Main occupation of survey respondents. Source: authors' compilation from PWKB survey data.

The other category includes a diverse range of occupations as follows:

- Amateur wildlife enthusiast
- Arborist
- Board Certified Entomologist serving the public
- Director of historical garden
- Doctor
- Facilities Manager
- Gardener, hobby gardener, home gardener
- House wife
- Retired academicians and teachers
- Independent contractor
- Manager in sugar industries
- Just a curious person (hobby) – translated from Nieuwsgierig (Dutch)
- Pathologist engineer
- Pest control provider / pest control services
- Semiochemical manufacturer /researcher

Regional differences exist in terms of survey respondents (Fig. 21). Most survey respondents (33%) in South America are government extension officers/ advisors. In North America (28%) and Middle East and Asia (31%), most survey respondents are students. Around 17% of all survey respondents in the Middle East and Asia are farmers/growers. In Europe, most survey respondents (27%) are researchers, while in Africa, most survey respondents are farmers/growers (21%).



**Fig. 21.** Occupation of survey respondents by region. Source: authors' compilation from PWKB survey data.

## Use of information and data from the PWKB

In general, survey respondents mainly use data and information from the PWKB for research and the identification of plant pests and diseases (Fig. 21), with nearly a third of survey respondents (108, 29%) using the PWKB mainly for research (Fig. 22). This concurs with existing evidence that e-resources are now one of the most popular tools in research and academic writing in the developing world (Haridasan and Khan, 2009; Sharma, 2009; Thanuskodi, 2012; Tella *et al.*, 2018; Bellary and Surve, 2019). Just over 20% of survey respondents (70 respondents) use the PWKB for identifying plant pests and diseases (Fig. 22). This shows that the PWKB is used for its stated purpose of 'Free access to a library of clear, practical and safe advice for tackling crop problems'.

A researcher from Kenya, Rahab Magoti of the Kenya Agricultural and Livestock Research Organization (KALRO) finds information on the PWKB very accurate. She also finds that the information is presented in a useful format for her needs. She has used the information for trainings and for capacitating a wide range of stakeholders including extension officers, students and her fellow colleagues. She downloaded the booklet builder with the most important crops in Kenya and printed the factsheets which she takes along to farmer trainings. She states that "I printed them in colour so that the farmers can easily recognize the problem, background, and details of a management technique. Farmers mostly learn by seeing and this makes it very easy to diagnose the problem." In addition she laminated additional copies for extension staff, thus ensuring they do not get torn quickly. She has also shared information from the website with her colleagues in KALRO as well as the many farmers and students that often call or visit KALRO seeking information on crop management.



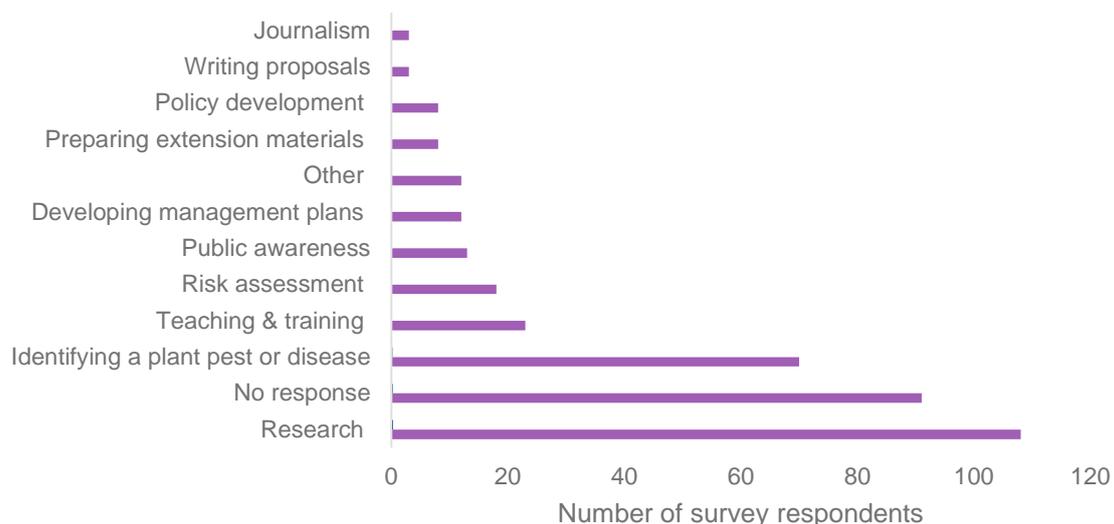
A farmer from the Netherlands has used the PWKB for risk assessments. He likes using the PWKB as it provides quick access to relevant information. He states that he searches the PWKB 'looking for host plants that are in the same family of plants I grow. So I can make a decision about the risk for my plants'.

Regional differences in terms of use of the PWKB data and information amongst survey respondents are observed (Fig. 23). In Africa, most survey respondents stated that they use the PWKB for identifying plant pests and diseases. To a lesser extent, survey respondents from Africa also use the PWKB resources for training and teaching and preparing extension

materials. The latter however is not very widespread as past studies have shown that extension staff exhibit limited usage of e-resources due to poor ICT) infrastructure, limited funding and low digital literacy levels (Mtenga et al., 2015). In North and South America, survey respondents use the PWKB data and information mainly for research and in the identification of plant pests and diseases. To a lesser extent, survey respondents from North and South America, were found to also use the PWKB resources for developing management plans and for training and teaching. In Europe, survey respondents mainly use the PWKB data and information for research. To a lesser extent, survey respondents from Europe also use PWKB resources for identifying plant pests and diseases and for training and teaching. In the Middle East and Asia, survey respondents use the PWKB data and information mainly for the identification of plant pests and diseases, and to a lesser extent for research.

A government extension officer from Costa Rica finds that the PWKB provides quick access to relevant information and increases the quality of his project work. He has used data and information from PWKB for various things including conducting research, developing management plans, identifying a plant pest or disease and preparing extension materials. He states that 'In my specific case, every day I attend to agricultural producers who require diagnoses and recommendations to solve their problems. PWKB has provided me with much needed information'.

### Main use of information from PWKB



**Fig. 23.** Main use of PWKB data and information by survey respondents. Source: authors' compilation from PWKB survey data.

**Table 1.** Use of information and data from PWKB by survey respondents. Source: authors' compilation from PWKB survey data.

Main use of PWKB data and information			Additional use of data and information		
Main use of PWKB (A)	No. of survey respondents	% out of total survey respondents	No. of respondents using PWKB for (A) + (B)	%	Other use (B)
Research	108	29%	56	52%	Developing management plans, <b>identifying a plant pest or disease</b> , preparing extension materials, public awareness, teaching or training, writing proposals, journalism, policy development, risk assessment
Identifying a plant pest or disease	70	19%	27	39%	Developing management plans, preparing extension materials, journalism, public awareness, teaching or training, risk assessment, writing proposals, research
Teaching and training	23	6%	8	35%	<b>Identifying a plant pest or disease</b> , developing management plans, research, journalism, writing proposals, preparing extension materials, developing management plans, risk assessment, policy development, public awareness
Risk assessment	18	5%	11	61%	Developing management plans, <b>identifying a plant pest or disease</b> , preparing extension materials, research, public awareness, teaching or training, writing proposals, research, policy development
Public awareness	13	4%	3	23%	<b>Identifying a plant pest or disease</b> , developing management plans, risk assessment, preparing extension materials, training or teaching
Developing management plan	12	3%	6	50%	<b>Identifying a plant pest or disease</b> , preparing extension materials, teaching or training, public awareness, writing proposals
Other	12	3%	-	-	Visit the site out of curiosity, college assignments, first time user, personal enlightenment, pest control services, production
Preparing extension materials	8	2%	5	63%	<b>Identifying a plant pest or disease</b> , research, risk assessment, public awareness, research, teaching or training
Policy development	8	2%	6	75%	Research, risk assessment, developing management plans, <b>identifying a plant pest or disease</b> , preparing extension materials, public awareness, journalism, teaching or training, writing proposals
Writing proposals	3	1%	2	67%	Research, training and teaching

Main use of PWKB data and information			Additional use of data and information		
Main use of PWKB (A)	No. of survey respondents	% out of total survey respondents	No. of respondents using PWKB for (A) + (B)	%	Other use (B)
Journalism	3	1%			No other uses
No response	91	25%			
Total	369	100%			

## Benefits of using the PWKB

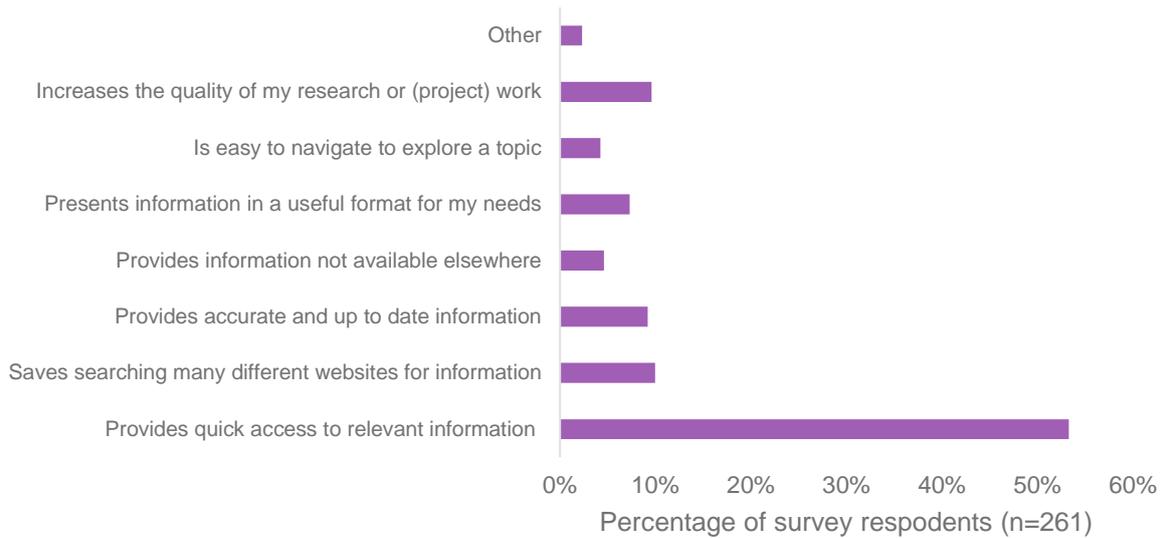
Among the survey respondents, we analysed those stating that they have used the PWKB for their work and thus have seen some benefits (70% or 261 of survey respondents). The main benefit stated by most survey respondents is that the PWKB provides them with access to relevant information (Fig. 24).



**Fig. 24.** Benefits of using PWKB – WordCloud. Source: authors’ compilation from PWKB survey data.

The WordCloud analysis is confirmed by the survey data which show that the main benefit stated by over half of survey respondents (53%) was that the PWKB ‘provides quick access to relevant information’ (Fig. 25). Other benefits such as ‘saves searching many different websites for information’ and ‘increases quality of research and project work’ were mentioned by 10% of surveyed respondents, respectively.

## Benefits of using PWKB



**Fig. 25.** Benefits of using the PWKB – survey respondents. Source: authors’ compilation from PWKB survey data.

These findings concur with other studies evaluating the benefits of e-resources in the developing world. This includes studies by Sharma (2009) from India who found that both university staff and students choose e-resources because they save them time, are easy to use and are useful in their work.

*“For farmers that have phones, I have shared with them the PWKB links. Farmers have provided feedback saying that the information given to them is very accurate, detailed and comprehensive, especially the decision guides.”* Rahab Magoti, Kenya Agricultural and Livestock Research Organization (KARLO), Kenya

Mr Eric Haraman, Programme Manager for Blantyre Agriculture Development Division, Ministry of Agriculture has used the PWKB during review meetings to capacitate the Plantwise team in Malawi. This has included sharing the link among all team members (coordination team, plant doctors, steering committee and agro-dealers). Farmers have been reached with the information from the PWKB during plant health rallies. In addition, the PWKB has assisted Malawi as a country to get information for plant health problems not yet reported in Malawi but which have been observed in neighbouring countries - this helps the plant health team in the country, including the National Plant Protection Organization, to be prepared and to work towards prevention.

## Suggestions for improving the PWKB

Survey respondents provided various recommendations for improving the delivery, type and access to the technical content of the PWKB as follows (Fig. 26):

1. Additional ways of sharing information with users
2. Technical areas where additional information should be provided
3. Suggestions for making the site more user friendly, visual and interactive

Other suggestions were also provided which focused on improving reach to more diverse users and for improving future surveys (Fig. 26):

1. Improve access to technical content and reach to farmers and others
2. Suggestions for future surveys

## 1

### Additional ways of sharing information

- A **video/audio platform** to improve learning
- Introduce **online courses**
- Introduce **degree online courses**
- Show a country's major crop diseases in **colour**
- There should be **PDF factsheets**, which can be printable for sharing with farmers

## 2

### Provide more information on various technical areas

- Update **species** pages regularly and provide information on when they were updated
- Updated **chemical/pesticide lists** and **management recommendations**
- More information should be **Abiotic factors** interfering with **plant health**
- Latest research to be updated regularly on any **species**
- Control measures of **pest and disease**
- Provide more information for **management recommendations**
- Need for country specific **pest management strategies**
- Need for updates on **chemicals / pesticides** which are being marketed for plant health.
- Provide country specific major **diseases and pests** and details of at-risk commercial crops in **colour**.
- Always really important to know when the information was **last updated/reviewed**
- Provide information about **organic solutions to plant health problems**.

## 3

### Make site more interactive and visual

- Showcase more **pictures** and make it more **interactive**
- Updated pest information and **pictures**
- **Pictures** are always useful too
- More **pictures** on plant health problems need to be included
- Make it more **interactive**
- Provide countrywise major diseases and pests and their details of commercial crops in **colour**.

## 4

# Improve access to information

- Improve access to the information on the site by making it **free access** and **responding in time** [to queries]
- Make it **easy to open and access** information
- Provide content in **local languages**
- Work with local communities and farmers directly without involving government sector
- There must be a way of getting to farmers without android phones especially the illiterate ones

## 5

# Future surveys

- **Share survey findings** upon completion
- **Improve survey with ability to enter certain requested fields** i.e. in this survey I was unable to enter my name, only email.

**Fig. 26.** Suggestions for improving delivery, type and access of technical content. Source: authors' compilation from PWKB survey data.

## Conclusions

An assessment was conducted of the use and benefits of the Plantwise Knowledge Bank (PWKB) using mixed methods. The findings show that the **PWKB is used by a wide variety of users from different countries in both Plantwise and non-Plantwise countries i.e. developing and developed countries.** In 2021, **most users, in general and specifically for Plantwise countries, were from Asian countries.** A few countries from East Africa and South America were however also found amongst the top ten countries with most users. For non-Plantwise countries, there was a mix of countries contributing the most users in 2021 that comprised many of the countries in Asia and North America, as well as a few in Africa, Europe and Australia. Other key findings are as follows:

- there is an **increase in the number of users, visits and page views in 2021** as compared to 2020, for both for Plantwise and non-Plantwise users.
- users of the PWKB in 2021 were repeat visitors who **accessed the site via organic searches on mobile devices.** However, users from non-Plantwise countries were more likely to access the site via desktop computers.
- most users are aware of the PWKB and used a search engine to find it i.e. organic search, with very few users coming via social sites and/or paid for searches.
- the site had **more men than women visitors in 2021.** For non-Plantwise countries, this was reversed with more women than men using the site in 2021.
- the top 10 most searched for terms stayed relatively similar, including 'fall armyworm', 'maize', and 'pest management decision guide'. This aligned with the most viewed content.
- there was a **fairly consistent number of visits from Wikipedia.** A surge in referrals were observed with the addition of a datasheet on *Dysdercus cingulatus*, which had the highest number of landing pages from the Wikipedia traffic in 2021.

From the Hotjar survey, we find that the PWKB caters for a wide array of stakeholders in the plant health ecosystem, and provides information for its target audience. The ecosystem of stakeholders includes but is not limited to farmers, academia, researchers, students, government officers working as policy makers and extension officers, private sector including agri-input suppliers as well as private citizens (i.e. housewives, hobby gardeners etc).

Data and information from the PWKB is used for a wide variety of activities. Three main uses of the data and information from the PWKB **stated by survey respondents is research, for identifying plant pests and diseases and for training/teaching.** Examples of the usage of information and data from survey respondents, **shows that the PWKB has applicability in solving real life problems and in creating solutions. The main benefit that survey respondents find from the PWKB is that it provides them quick access to relevant information.** Secondary benefits that survey respondents find is that the **PWKB saves them searching many different websites for information and it increases the quality of their research and project work.**

## Limitations

- The study has one main limitation arising from our selected methodology. Google Analytics (GA) does not and cannot guarantee to capture every 'country' data point for every user/visit. This is because of a number of reasons. For example, users on a Virtual Private Network (VPN), or other similar software, could choose to hide their geo-location or they may have tracking blocker software installed which restricts the data sent to GA. Other users may choose to hide or obfuscate their IP address, which is what the country data point is derived from. In addition, when we apply filters to a GA data, e.g., applying a country filter to visits, GA can choose to sample the data rather than report at 1-1 ration - this is due to data constraints on the free GA account. Hence some visits/users will not have the country data point.

## Recommendations

- Most users in Plantwise countries access the site via mobile phone. This therefore requires continuous site optimization for mobile users to ensure increased and continued access by target users.
- Most site visitors are looking for quick access to relevant information. This can be met by prioritizing the most searched and viewed sections on the homepage.
- There is need to further explore how to increase traffic from various online platforms and social sites to take advantage of this space and reach a greater target audience.
- There is need to include more images and pictures such as symptom images in the diagnostic search and use more visuals to attract and keep audiences engaged.
- Efforts should be explored to provide content in languages other than English due to the diversity of users and demand for local languages.
- Future areas for research should focus on user behaviour and/or user journeys to better understand user interaction with the site and content.

## Acknowledgements

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# Annexes

## Annex 1: Survey tool

Plantwise Knowledge Bank user survey

We are currently carrying out a study to investigate how the PWKB is used and what benefits it brings to its users. We are collecting stories about its impact, to help us demonstrate its value. We would like to ask some simple questions about your use.

The survey will take about 5 minutes of your time, and you will be given a chance to enter into a prize draw, once you have completed the survey. The information from this survey will remain anonymous.

Would you like to take part in the survey?

----- If yes, takes you to the questions below -----

1. What is your main occupation?
  - a. Agri-input supplier
  - b. Government extension officer/ advisor
  - c. Private extension service provider
  - d. Farmer/grower
  - e. Government official
  - f. Regulator
  - g. Researcher
  - h. Student
  - i. University staff
  - j. NGO staff
  - k. Other
    - i. If 'other' please specify
  
2. How does use of the PWKB help in your work? (tick all that apply)
  - a) Provides quick access to relevant information
  - b) Saves searching many different websites for information
  - c) Provides accurate and up to date information
  - d) Provides information not available elsewhere
  - e) Presents information in a useful format for my needs
  - f) Is easy to navigate to explore a topic
  - g) Increases the quality of my research or (project) work

- h) I have not used the PWKB for my work
- i) Other – FREE TEXT BOX (only appears when choose this option)

3. What have you used information or data from the PWKB for (tick all that apply)

- a) Research
- b) Policy development
- c) Risk assessment
- d) Developing management plans
- e) Identifying a plant pest or disease
- f) Preparing extension materials
- g) Public awareness
- h) Journalism
- i) Teaching or training
- j) Writing proposals
- k) Other (please include details below) FREE TEXT BOX (only appears when choose this option)

4. Please could you share an example of how you have used the PWKB in your work?

FREE TEXT BOX

- May we cite this example in a public report on the use and benefits of the PWKB? (The information will remain anonymous, unless you wish to be cited) **YES/NO OPTION**
- Please provide your contact details including your name and email address. By providing this information you will be entered into our prize draw.
- May we contact you for follow up questions on this example? **YES/NO OPTION**

5. Male or Female?

6. Do you have any suggestions to improve the PWKB that you would like to share?

FREE TEXT BOX

THANK YOU FOR YOUR TIME

#end of survey

## contact CABI

### Africa

#### Kenya

**CABI**, Canary Bird  
673 Limuru Road, Muthaiga  
PO Box 633-00621  
Nairobi, Kenya  
**T:** +254 (0)20 2271000 / 20  
**E:** africa@cabi.org

#### Ghana

**CABI**, CSIR Campus  
No. 6 Agostino Neto Road  
Airport Residential Area  
P. O. Box CT 8630, Cantonments  
Accra, Ghana  
**T:** +233 (0)302 797 202  
**E:** westafrica@cabi.org

#### Zambia

**CABI**, Southern Africa Centre  
5834 Mwange Close  
Kalundu  
P.O. Box 37589  
Lusaka, Zambia  
**T:** +260 967 619 665  
**E:** southernafrica@cabi.org

### Americas

#### Brazil

**CABI**, UNESP-Fazenda Experimental  
Lageado, FEPAF (Escritorio da CABI)  
Rua Dr. Jose Barbosa de Barros 1780  
Fazenda Experimental Lageado  
CEP:18.610-307  
Botucatu, São Paulo, Brazil  
**T:** +55 (14) 3880 7670  
**E:** y.colmenarez@cabi.org

#### Trinidad & Tobago

**CABI**, 59 Gordon Street, Curepe  
Tunapuna 331323  
Trinidad and Tobago  
**T:** +1 868 6457628  
**E:** caribbeanLA@cabi.org

#### USA

**CABI**, 7200 Portland Street  
Boston, MA 02114, USA  
**T:** +1 (617) 682-9015  
**E:** h.jansen@cabi.org

### Asia

#### China

**CABI**, Beijing Representative Office  
Internal Post Box 85  
Chinese Academy of Agricultural Sciences  
12 Zhongguancun Nandajie  
Beijing 100081, China  
**T:** +86 (0)10 82105692  
**E:** china@cabi.org

#### India

**CABI**, 2nd Floor, CG Block,  
NASC Complex, DP Shastri Marg  
Opp. Todapur Village, PUSA  
New Delhi – 110012, India  
**T:** +91 (0)11 25841906  
**E:** india@cabi.org

#### Malaysia

**CABI**, PO Box 210,  
43400 UPM Serdang  
Selangor, Malaysia  
**T:** +60 (0)3 89432921  
**E:** cabisea@cabi.org

#### Pakistan

**CABI**, Opposite 1-A,  
Data Gunj Baksh Road  
Satellite Town, PO Box 8  
Rawalpindi, Pakistan  
**T:** +92 51 9292062  
**T:** +92 51 8434979  
**E:** cabi.cwa@cabi.org

### Europe

#### Switzerland

**CABI**, Rue des Grillons 1  
CH-2800 Delémont, Switzerland  
**T:** +41 (0)32 4214870  
**E:** europe-CH@cabi.org

#### UK

**CABI**, Nosworthy Way  
Wallingford, Oxfordshire, OX10 8DE, UK  
**T:** +44 (0)1491 832111  
**E:** corporate@cabi.org

**CABI**, Bakeham Lane  
Egham, Surrey, TW20 9TY, UK  
**T:** +44 (0)1491 829080  
**E:** cabieurope-uk@cabi.org  
**E:** microbialeservices@cabi.org