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Drones in Agriculture in Africa and other ACP countries A Survey on Perceptions and Applications

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Giacomo Rambaldi

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Drones in Agriculture in Africa and other ACP countries

A Survey on Perceptions and Applications

Denise Soesilo and Giacomo Rambaldi





About CTA

The Technical Centre for Agricultural and Rural Cooperation (CTA) is a joint international institution of the African, Caribbean and Pacific (ACP) Group of States and the European Union (EU). CTA operates under the framework of the Cotonou Agreement and is funded by the EU. For more information on CTA, visit www.cta.int

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Executive summary

In October 2017, the Technical Centre for Agricultural and Rural Cooperation ACP-EU (CTA) in partnership with the NEPAD Agency¹, conducted a survey to understand the perceptions surrounding the use of drones for agriculture. Approximately 13,000 individuals (mainly English and French-speaking readers of CTA e-publications or members of CTA-managed communities of practice) received an invitation to participate in the survey. The aim was to understand the general perceptions on the use of drones amongst stakeholders in agriculture and development cooperation with an emphasis on African regions. 16%, or a total of 1432 individuals (of whom 91% have worked or are currently working in Africa), completed the survey and had at least a working knowledge of drones in agriculture.

Results show that there is general optimism about the prospects of the deployment of the technology. 85% of survey participants said that they view the use of drones in agriculture favourably. They believe drones play an integral part in modernising agriculture and increasing yield and efficiency. Respondents consider that some of the most important applications include the assessment of crop health, the generation of topographical maps and the detection of varying rates of fertiliser applications on large holdings. In addition, the use of drones to detect and control pests and diseases, and the ability to rapidly collect information over large areas was most often cited as a reason for the favourable views.

Those that think less favourably about the technology most often expressed concerns that drones may not be an adequate tool to support current needs of smallholder and subsistence farmers. High costs and complexity of the technology were often perceived as challenges for its use by smallholders and less prosperous farmers. While agriculture is developed and modernised with the introduction of this technology, the interests and livelihoods of artisanal fisheries and smallholder farmers should be protected, according to some respondents.

84% of the respondents agree that awareness about the technology is generally low. They pointed out that additional information to understand the technology and its use and applications in agriculture are needed and would be welcomed. Especially, robust awareness raising and capacity building appear to be the suggested inputs.

¹ The New Partnership for Africa's Development (NEPAD) Planning and Coordinating Agency is the technical arm of the African Union and set to become the development agency. NEPAD was adopted at the 37th session of the Assembly of Heads of State and Government in July 2001 in Lusaka, Zambia.

Résumé en français

En octobre 2017, le Centre technique de coopération agricole et rurale ACP-UE (CTA), en partenariat avec l'Agence du NEPAD², a mené une enquête pour comprendre comment l'utilisation des drones dans l'agriculture est perçue. Environ 13 000 personnes (principalement des lecteurs anglophones et francophones de publications électroniques du CTA ou des membres de communautés de pratiques gérées par le CTA) ont été invitées à participer à l'enquête. L'objectif était de comprendre comment les acteurs de l'agriculture et de la coopération au développement percevaient l'utilisation des drones en général, notamment dans les régions africaines. Un total de 1432 personnes (soit 16%, dont 91% qui ont travaillé ou travaillent actuellement en Afrique) ont participé à l'enquête et avaient au moins une connaissance pratique des drones dans l'agriculture.

Les résultats montrent que les perspectives de déploiement de la technologie sont généralement accueillies avec optimisme. 85% des participants à l'enquête ont déclaré qu'ils étaient en faveur de l'utilisation des drones dans l'agriculture. Ils pensent que les drones jouent un rôle essentiel dans la modernisation de l'agriculture et dans l'augmentation des rendements et de l'efficacité. Les répondants considèrent que certaines des applications les plus importantes sont l'évaluation de la santé des cultures, la génération de cartes topographiques et la détection de taux variables d'application d'engrais sur de grandes exploitations. En outre, la détection des ravageurs et des maladies ainsi que la collecte rapide d'informations sur de vastes zones ont été les plus souvent citées comme raisons des opinions favorables.

Ceux qui sont moins en faveur de la technologie doutent que les drones constituent un outil adéquat pour répondre aux besoins actuels des petits exploitants et des agriculteurs de subsistance. Les coûts élevés et la complexité de la technologie étaient souvent perçus comme des défis pour son utilisation par les petits exploitants et les agriculteurs moins riches. Alors que l'agriculture s'est développée et modernisée avec l'introduction de cette technologie, les intérêts et les moyens de subsistance des pêcheries artisanales et des petits exploitants agricoles devraient être protégés, selon certains répondants.

84% des répondants pensent que la connaissance de la technologie est généralement faible. Ils ont souligné que des informations supplémentaires pour comprendre la technologie, son utilisation et ses applications dans l'agriculture sont nécessaires et seraient les bienvenues. Ils suggèrent notamment des efforts accrus de sensibilisation et un renforcement des capacités.

² L'Agence de planification et de coordination du Nouveau partenariat pour le développement de l'Afrique (NEPAD) est l'organe technique de l'Union africaine et devrait devenir l'agence de développement. Le NEPAD a été adopté lors de la 37^e session de l'Assemblée des chefs d'État et de Gouvernement en juillet 2001 à Lusaka (Zambie).

1 Introduction

Agriculture is one of the most promising emerging markets for the international drone industry. Projections show that agriculture will soon form the second largest market globally for drone-related services³. A large agricultural area that would take days to inspect by car or on foot can be surveyed within hours or minutes using drones, making it possible to monitor vast fields of crops on a regular basis. In so-called precision agriculture, specialised sensors that are mounted on drones help to glean information about where crops require intervention even before signs of distress become visible to the naked eye. This allows for early and more precise treatments where irrigation, fertilisation and pesticide needs are most urgent, thus lowering overall input of resources and reduction of fertiliser and pesticide use. Disease outbreaks can be detected and therefore countered at early stages before major damage occurs. Increasingly, drones are also used for post-disaster assessments and transporting medical supplies. All mayor development agencies have shown interest in the technology. The Technical Centre for Agricultural and Rural Cooperation ACP-EU (CTA) has been supporting the responsible use of unmanned aerial systems (UAS) for agriculture in African, Caribbean and Pacific (ACP) countries since 2015, has contributed to the drafting of a study launched by NEPAD Agency on behalf of the African Union on the use of drones for precision agriculture and – as part of its 2018-2019 strategy – is planning to support the development of UAS-based advisory services, mainly run by young entrepreneurs servicing agribusinesses and farmers' cooperatives.

Various terminologies are used when referring to unmanned aircraft. The public and media often use “drone”. The term unmanned aerial vehicle (UAV) refers to the unmanned aerial vehicles. The term unmanned aerial system (UAS) denotes the larger system of the airborne portion, the UAV, the pilot located elsewhere, controlling the aircraft via a ground control station through wireless linkages (control and command links) plus the sensor(s) mounted on the UAV and the software that may be used to analyse the data gathered by the sensor(s). A UAV can be operated manually, be programmed to operate automatically, or be fully autonomous.

2 Methodology

2.1 Recipients

Invitations to participate in the survey were sent to 13,010 individuals who usually receive CTA digital newsletters and publications or who are members of CTA-nurtured communities of practice.

2.2 Data collection

The survey, administered via a specialised service, *SurveyMonkey*, in both English and French, remained open for 15 days from 10 – 25 October 2017. Participation in the survey was open to invited respondents mostly active in the agricultural domain in African, Pacific and Caribbean (ACP) states⁴. 68% of the recipients of the invitations were anglophone and the remainder francophone. The response rate was 13.6%, which is in line with most

³ PwC market study: <https://www.pwc.pl/pl/pdf/clarity-from-above-pwc.pdf>. See also <https://pwc.to/2F7UNAw>

⁴ These include East Africa, Central Africa, West Africa and Southern Africa, the Caribbean and the Pacific.

external online surveys nowadays (10%-15%)⁵. A screening question at the onset of the survey ensured that only those who had a working knowledge of what drones in agriculture are, would continue and take the complete survey. A total of 337 responses were thus screened for insufficient knowledge about the technology. In this manner, a total of 1,432 survey responses were recorded and analysed.

2.3 About the respondents

More than one third of the respondents self-identified as scientists or researchers, and nearly one fourth identified as development practitioners. About 10% of respondents are farmers and a small fraction are drone pilots⁶. The most represented sectors are academia and research (25%), ministries and extension services (14%) and civil society organisations (14%)⁷. The great majority, 1,298 (91%) of survey respondents, said they work in Africa. Western and Eastern Africa were most represented followed by Southern and Central Africa. The Pacific, Caribbean and Europe were represented by a small fraction each, and Northern Africa was the least represented with 3% of respondents claiming that they work in the region. 21% of survey respondents were women.

Out of the 1,432 responses which were considered for the analysis, 13% were already using drones either for agriculture or for other activities. 63% claimed to have a good understanding of the technology, and 20% claimed that they only had a basic working knowledge of the technology.

2.4 Data analysis

Data was analysed with the purpose to understand the reasons for various perceptions on drone use in agriculture, as well as the opportunities and challenges perceived by the respondents. For the categorical and numerical data, the chi-square test of independence was used to probe if there were linkages between professional, language, or regional background and perceptions.

Textual answers to open-ended questions were aggregated into word clouds. In addition, manual text classification was used to identify the most common responses. Respondents were invited to provide written justification about their choices or to provide additional comments. Providing participants with sufficient space to voice their opinions freely was seen as important to allow for the widest range possible in the expression of opinions. Overall, more than 4,000 text comments were collected. In the analysis, most common response types are mentioned in decreasing order of prevalence for each section. In many cases, representative quotes of common responses are used to exemplify the various opinions. French comments were translated into English for the purpose of this report.

⁵ Survey response rates 2017, PeoplePulse. Consulted online on 27/11/2017 at <https://www.peoplepulse.com/resources/useful-articles/survey-response-rates>

⁶ For a full breakdown, see Annex 1.

⁷ Other sectors were represented as follows: Research institute (12%), private enterprise (11%), regional/international organisation/intergovernmental organisation/donor (7%), agribusiness (5%), farmer organisation/co-operative (4%), other (3%), media (3%), public library (national/town library)/information centre (1%), embassy/diplomatic organisation (1%), and national civil aviation authority/ICAO (<1%) and space agencies (<0%).

3 Key findings

3.1 Perceptions

The majority, 59%, said that they view the use of drones very favourably, and 26% somewhat favourably. Merely 10% were neutral, and even less respondents, 5%, think of drones in agriculture somewhat unfavourably or very unfavourably.

The data does not indicate any significant differences in perception based on region, profession and experience. However, surprisingly, language seemed to play a role as there are significant differences in terms of perception between French and English speakers. The French survey respondents showed a greater overall tendency to view agricultural drones less favourably than English speakers ($p < 0.01$).

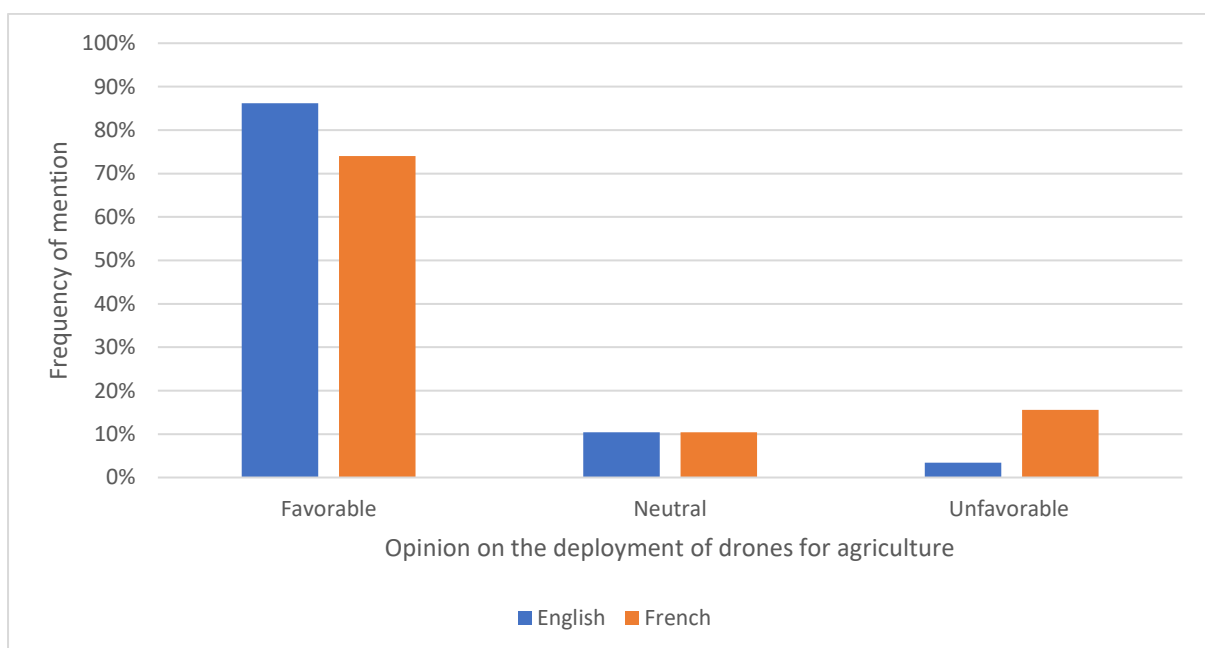


Figure 1: Perceptions based on language spoken by the respondent

The respondents were asked to also describe and be specific on what influenced their opinions. This field was optional, but 790 English speakers and 446 French speakers offered sometimes quite elaborate explanations. A summary of the most common response types is provided in the sections below.

3.1.1 Unfavourable views

Among the survey participants, those who stated that they view the use of drones unfavourably were rare (5%). However, many of those who did have a neutral or somewhat favourable view, shared some of the concerns that those with unfavourable views voiced, which merits a wider discussion of the perceived adverse effects. A summary of the most cited concerns and criticisms is given below.

The majority of unfavourable views are based on a concern for the needs of smallholders and the perceived lack of benefit for them. For example, a researcher from Eastern Africa stated that “[d]rones in agriculture are mostly used by medium to large scale farmers yet [the] majority of the farmers in Africa are smallholders who can't benefit from the

technology". Similarly, a business person and farmer in West Africa writes that "[i]n Africa, we still have enough problems with electricity and the internet in rural areas. It will be difficult for us to use drones in order to make farms profitable, especially the family type, which characterises our agriculture". In addition, quite a few also perceive that costs would be a hindrance to smaller farmers, as exemplified by the following comment by a government official and researcher from Western Africa: "[Drone-related-technology] is expensive and excludes the small producers".

Other survey participants criticised the technocratic approach to solving issues in agriculture that they felt may eventually lead to more, not fewer problems.

An entrepreneur from Central Africa wrote: "I wonder if this is not another invention that will cause more environmental problems than it can solve". On a related note, a researcher wrote: "They are expensive, and I am not convinced that a great many of them won't end up in landfills within the next ten years".

A development practitioner working in Southern Africa commented as follows, raising concerns not only of lost skills and displacement of small farmers, but also of the large business interests involved – an issue also brought up by several of the participants: "Technology to improve agriculture yields is a choice of society decided by technocrats that may have a positive short-term impact on some farming practices and yields. But on the long term it changes the social and cultural relations between farmers, their environment and their ability to understand the constraints and develop their own solutions in an autonomous way. Plenty of examples around the world of farming communities, technologies, agro-ecological alternatives, show that farmers did and can still do without such technologies to find solutions to their constraints. Introducing drone in agriculture is another step towards more dependency towards technologies and withdrawing the expertise from farmers to sell it to business companies. Therefore, the use of drone in agriculture is a seducing but false solution that will little by little increase the vanishing of the peasants to the profit of technocrats".

A few of the commenters were also concerned about privacy and data implications. An education specialist based in Europe writes that "[d]rones risk participating in the surveillance of the citizens, without [the population] being aware of it".

Lastly, job loss and replacement of labour force was also a concern brought up on several accounts in comments similar to the following: "Small scale farmers constitute over 60% of the labour force, using drones will mean displacing the farmers from their means of livelihood".

3.1.2 Neutral views

About 10% of survey participants adopted a neutral view on the use of drones in agriculture. Many who fall into this category chose to refrain from giving an opinion in favour or against agricultural drones, because they feel that they do not have enough information or experience. Many commented along the lines of "I am not informed about its use in agriculture".

Others felt that there may be some benefits to using drones, but they were concerned about capacity and costs. One development practitioner from West Africa wrote: *“Agriculture is not yet sufficiently developed in Africa to use drones”*. Another wrote: *“The level of technology and capital endowment is low in [my country]”*. Concerns regarding the benefit of this technology to smallholders, already mentioned by those who view the technology negatively, were echoed as well.

Others with neutral sentiments balanced their expectations of the positive impact against potential negative impacts the technology could have. Participants cited examples of negative impact that they fear the widespread use of drones might have on the environment and wildlife. *“I think using drones can help improve performance, but I'm wondering about their impact on the environment”* and *“Where I am working, there were incidences of human and wildlife conflict that were attributed to agitation caused by drones, and elephants destroyed homes”*.

Lastly, some of those with neutral views felt that they had not seen enough evidence of the positive impacts. Further, there was a sentiment that the development should be done slowly over the years under careful evaluation of the impacts the technology could have.

3.1.3 Favourable views

85% of respondents stated that they view the use of drones in agriculture somewhat or very favourably, indicating a general optimism and openness to explore the potentials of drone-based technology for agriculture. The use of drones to detect and control pests and diseases, and the ability to rapidly collect information over large areas was most often cited as a reason for the favourable views.

Especially researchers are vocal about the benefits they perceive would come from the technology as the following examples show: *“Drones will make agriculture more environment-friendly and sustainable, by reducing the application of pesticides, fertilisers, water and other inputs”*. Another researcher based in West Africa wrote that *“[a]s a pathologist, it will help in disease assessment hence effective control and improved/ increased yield”*. Similarly, a researcher and drone pilot working the Pacific shared that *“[a]t the institute where we work, we use drones to manage some plantations and they help us to reduce time in assessing them. They are a great tool for plantation management and disease detection”*.

Drones were also mentioned often as effective for fertiliser management. A teacher from East Africa wrote that *“[d]rones are an effective way of advancing agriculture particularly when it comes to accurate analysis of fertility of soils and application of fertilisers. Furthermore, proper analysis and identification of areas in agriculture that need critical attention is very key for farmers in accessible areas”*.

Especially the ability to access and assess difficult to reach areas very rapidly and the potential to save time for monitoring tasks was a factor that was particularly often cited. One survey participant states that drones are *“convenient, [and] allow ... to reach the most distant areas very quickly”* and another wrote that *“drones help in rapid decision-making in many cases”*.

Having access and data available fast leads to *“effective and rapid contribution to the resolution of agricultural problems: management of perimeters, management of diseases and enemies, soil fertility, area measurements; monitoring ...”*

Experienced drone users often mentioned the advantage of drone images provided compared to satellite data: *“Speed of action and precise aerial view [achieved with drones] compared to satellite images”* is seen as superior. Cost benefits were also mentioned: *“Drones are cheap compared to conventional survey methods e.g. taking pictures from an aeroplane or purchasing high quality satellite images”*. This indicates that especially practitioners who have been using remote images such as from satellites and airplanes in the past perceive a strong benefit from drone technology.

Several participants stated that they think positively about the use of drones in agriculture, because they have participated in workshops or have been able to research, read about or hear about the uses in various media without having used the technology themselves. *“My research into drone technology has made me understand the huge potentials that drones offer for precision agriculture in terms of cost savings, ease of monitoring crops and livestock, timeliness of data, etc”*. There are indications that those who have been exposed to information material tended to think more favourably about the technology.

Many also outlined certain challenges that need to be solved in order to bring about the most benefits from the technology. The need for capacity building is a recurring theme. A researcher based in Eastern Africa wrote that *“[t]here is no adequate awareness raising for the general public on side effects, if any. This includes health and/or privacy of rural communities, as well as urban communities”*. The same commentator then mentioned concerns around commercialisation of data: *“One can never tell what additional data may be collected from rural or urban areas. As there is no adequate capacity to manage data in developing countries, this has also implication of losing intellectual property. There is a need to first build capacities of African universities and research organisations to manage their data before investing on technologies such as drones”*.

Opportunity costs and the need to think broadly was also voiced by several. Worth noting is the following comment by a manager and development practitioner: *“While I think it is a very interesting technology, its practical applications are limited (at present). I think there is a need to be realistic about what it can and can't do. I think we need to think a bit more broadly than just UAVs. Stationary sensor stations with wireless data links may offer other kinds of functionality for a fraction of the price and complexity. Or autonomous ground-based vehicles”*.

Very often, respondents specified that they think there is most potential when drones are used where large areas of water or land need to be monitored or surveyed and are complimentary to other data acquisition methods. *“Best-use cases are limited to large land/sea tracts, and even then, information collection can only be little more than spot checks. Complementary systems (e.g. satellites) are required, to complete most projects (e.g. early warning).”*

Others pointed that the use may be feasible if farmers are organised in cooperatives or similar unions: *“The largest part of [...] farmers is small-scale and subsistence in nature -*

their individual engagements also involve a multitude of crop types that require diversities of treatments. Thus, specifying the utility of drones may [present] significant challenges yet the relative cost of acquiring a drone may not make the technology feasible, for the individual farmers. At least in Africa as a general rule, we may need to bundle a number of farmers together, in order to be served by a single drone feasibly. And as such, there application of the technology could remain on generic field aspects, that invite for a thorough articulation of need being addressed”.

There is hope that drones and the exciting innovation potential that they bring may lift farmers out of their everyday drudgery. A survey respondent emphatically wrote that “[o]ne cannot over-emphasise the importance and uniqueness of precision agriculture, which involves the use of drones. To imagine how much drudgery is reduced as a result of drone usage in agriculture is very important”. Another noted that “[d]rones and robots can help avoid drudgery involved in agricultural activities. Can be time saving and reduces labour intensiveness.”

Lastly, people said that they felt that one should not forego innovative practices and solutions, if they can support agriculture. Some survey participants saw drones as forming part of a trend of innovation that is seen in a positive light by virtue of being innovative. “Africa’s agriculture is fragile – diseases, pests and sometimes unpredictable weather conditions. We need to make timely analyses if we are to minimise losses. We have to take advantage of technological advancement if we are to benefit from our agriculture.”

A government official in West Africa wrote that “any development in any sector of the economy has to have some form of integrated science and technology ingrained in [it]. Use of drones in agriculture could well be one of the most innovative and advantageous novelties for agricultural development. I’d say – go for it.”

3.2 Applications of most interest and opportunities

Survey participants were asked to evaluate and rank UAS-specific applications according to perceived importance in agriculture. There seemed to be little differentiation in terms of importance that participants assigned to the proposed drone-technology-based activities. However, all the proposed options were rated to be at least moderately important. The analysis was thus limited to participants who have used drones for agricultural activities before. This group of experienced users rated the use of drones to assess crop health as the most important function. The use of drones for stockpile volume calculations was seen as relatively less important than other applications, even though on average it was still rated as moderately important.

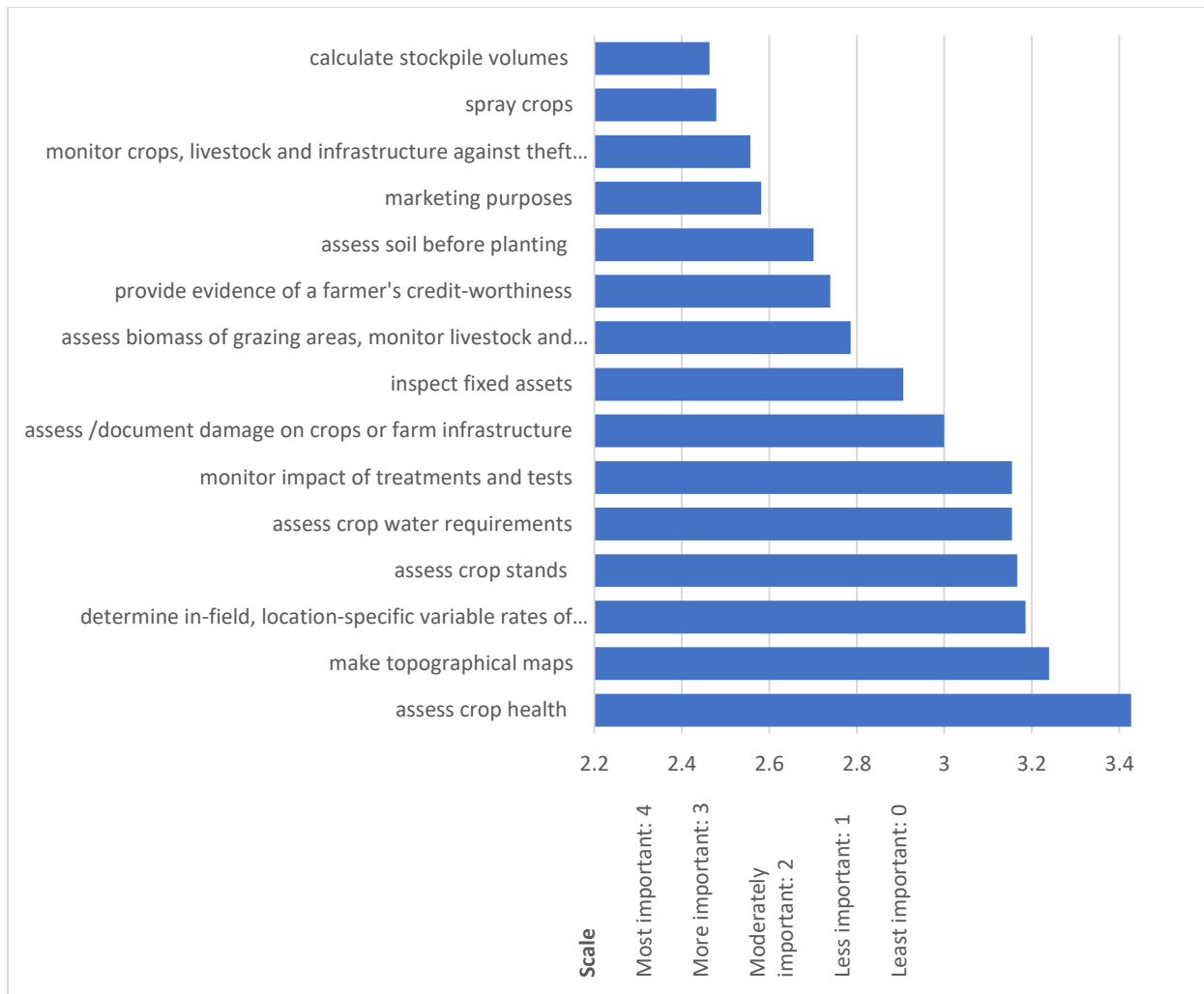


Figure 2: Perceived importance of activities according to experienced users

Based on text answers, participants believed that there were especially opportunities to use drones in the monitoring and assessments of crops and livestock, in the management of pests and diseases, increasing crop production and in research activities. Drones were also often mentioned as useful tools surveying irrigated crops such as maize and rice and in the related management of water.

3.3 Potential problems

When asked to elaborate on what problems people perceived regarding the implementation and use of drones in agriculture, regulations, security and costs were most often cited, followed by awareness issues and lack of information about agricultural drone applications. French speakers more often cited the cost factor as a potential problem compared to English speakers.

Labour displacement was a concern mentioned several times: *“Small scale farmers constitute over 60% of the labour force, using drones will mean displacing the farmers from their means of livelihood.”*

Capacity was also mentioned ranging from illiteracy of rural farmers to lack of policies, training and funds. *“In my country, the use of drones is far from becoming a reality because this area has not yet been well developed, being a result of political issues”* and *“If applied in developing areas, there would be a technology hurdle for locals.”*

Some participants were also concerned about privacy and security issues and misuse of the technology, either wilfully or due to lack of knowledge on responsible use. Regulations, the lack thereof, or the over-regulating of drones’ use was mentioned often. Conversely, others commented that they did not see any problems with the deployment of drones at the moment.

3.4 Other comments

In the comments’ section, participants often mentioned that awareness was still lacking and that more information, training and capacity building would be needed and welcomed. The need for awareness was stressed most often.

“As with any technology, there is a minimum necessary investment in capital and capacity development to use the tech, but 90% of any funds should be on the social preparation for the use of technology, for support, and for long-term developments with people using technology.”

“While promoting the technology, please think about how the low-income farmers should afford the technology.”

3.5 Data disaggregation

3.5.1 Differences among French and English-speaking respondents

There are some differences between the francophone and anglophone respondents that are worth noting. Overall, the French-speaking survey participants seemed to be less informed on the use of drones. 21% of French survey takers noted that they did not have even a basic idea about what drones in agriculture are, in contrast to only 13% of the anglophones. Further, only 9% of the francophone respondents had used drones at the time of the survey whether for agriculture or other applications. This again contrasts with the significantly higher percentage of 15% of English-speaking survey takers who have had experience with drones. Furthermore, French speakers were significantly less favourably inclined regarding the potential use of drones in agriculture. Interestingly, while language did play a role, neither the indicated work region, nor gender or professional position, showed any significant differences in perception data.

While there are many possible causes for this discrepancy, one possible explanation might be that there is in general much less information and material available in French about drone technology in agriculture. There seem to be some linkages between how aware people are of the technology and how favourably they view its potential applications.

3.5.2 Africa versus global survey results

91% of the survey respondents are based or work in Africa compared to only 3% in the Pacific and Caribbean respectively. The global survey data is nearly indistinguishable from the African data for this reason. The results for Africa only are listed in Annex 2 of this report.

4 Conclusions and recommendations

Broadly speaking, the survey reveals that among those queried there is support for the development and use of drones in agriculture – provided that certain key challenges are addressed. Only very few individuals felt that the potential negative implications outweigh the potential positive impact to the degree that they had a negative view of the technology. Most people felt optimistic in general about the potential uses.

The need for awareness was a major theme across all survey questions. Most survey takers agreed that awareness on the use of drones in the agriculture sector is generally low and awareness may potentially be lower among non-English speaking populations due to fewer materials available.

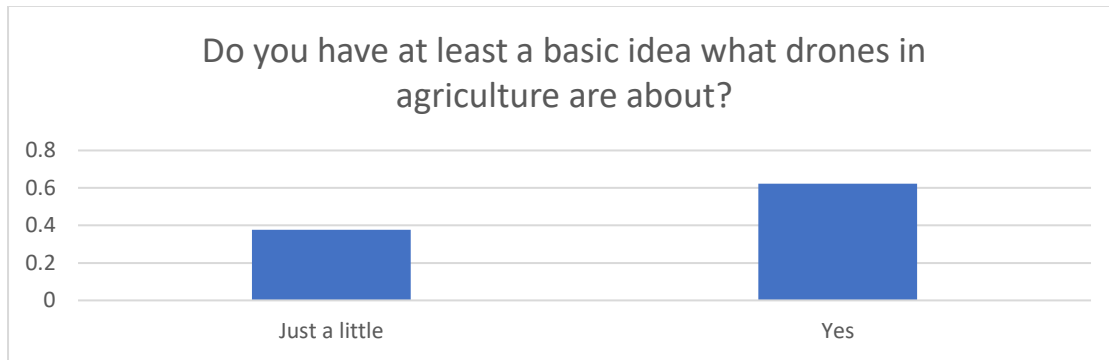
A general concern for potential opportunity costs that may disadvantage smallholders was a second theme that emerged, and responses indicate that drones are not seen as a universally applicable technology. Participants were often sceptical that the technology would benefit smallholders or at least concerned that other needs in support of smallholders would be neglected “*when promoting this technology*”. High cost of the technology was also mentioned often as a potential impediment leading to a general belief that the high costs in association with the lack of knowledge and information would make the technology unreachable to many farmers in rural areas. There are clear indications that a great amount of survey takers perceive drones in agriculture primarily as a technology to be deployed on very large areas, industrial crops, large-scale operations, or where smallholders growing the same crop are grouped in cooperatives or other forms of associations.

In moving forward, the concerns that have been raised should be well understood, researched, and if necessary mitigated. These include environmental impact due to obsolete electronics and batteries, the displacement of labour due to increased efficiency and a substantial change in agricultural practice or loss of skills in interpreting the signs of nature due to increased reliance on automated crop diagnostic. In addition, any future upscaling in the deployment of drones in agriculture should be done proportionally to the benefit that they provide. Especially, capacity building, training and education seem to be perceived as crucial steps forward.

Annex 1: Questions and graphical responses summaries

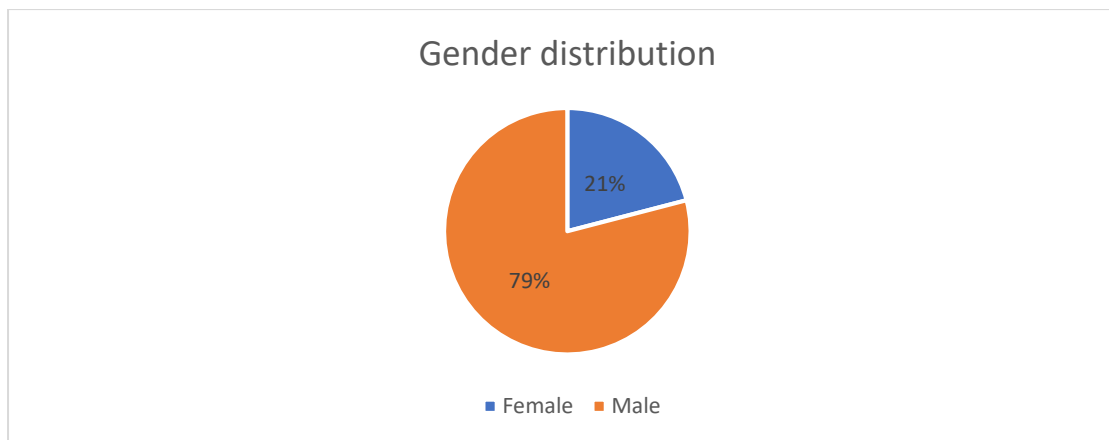
1. Introduction

1.1. Do you at least have a basic idea of what drones in agriculture are about?

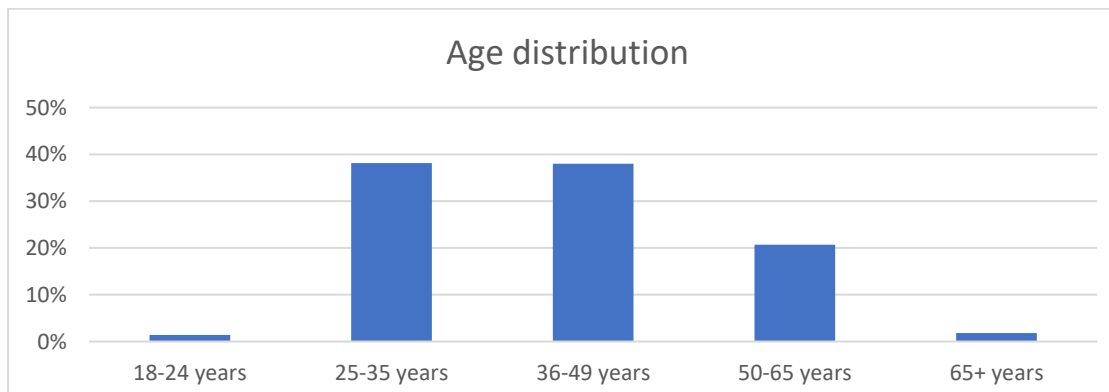


2. Background

2.1 Gender

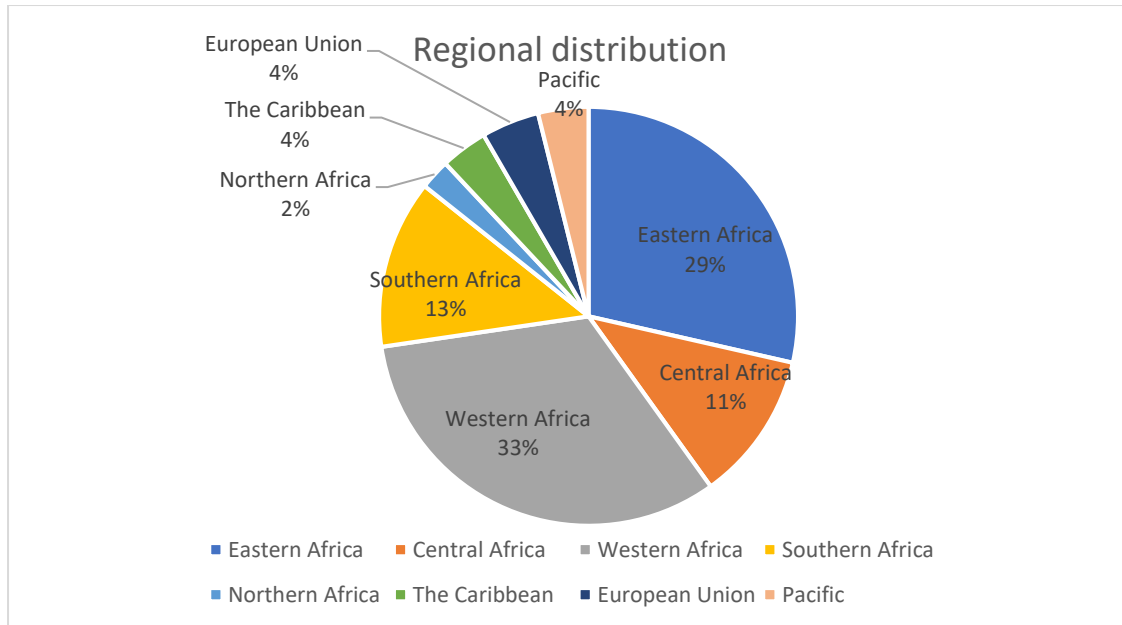


2.2 Age distribution



2.3 How would you define your role in development?

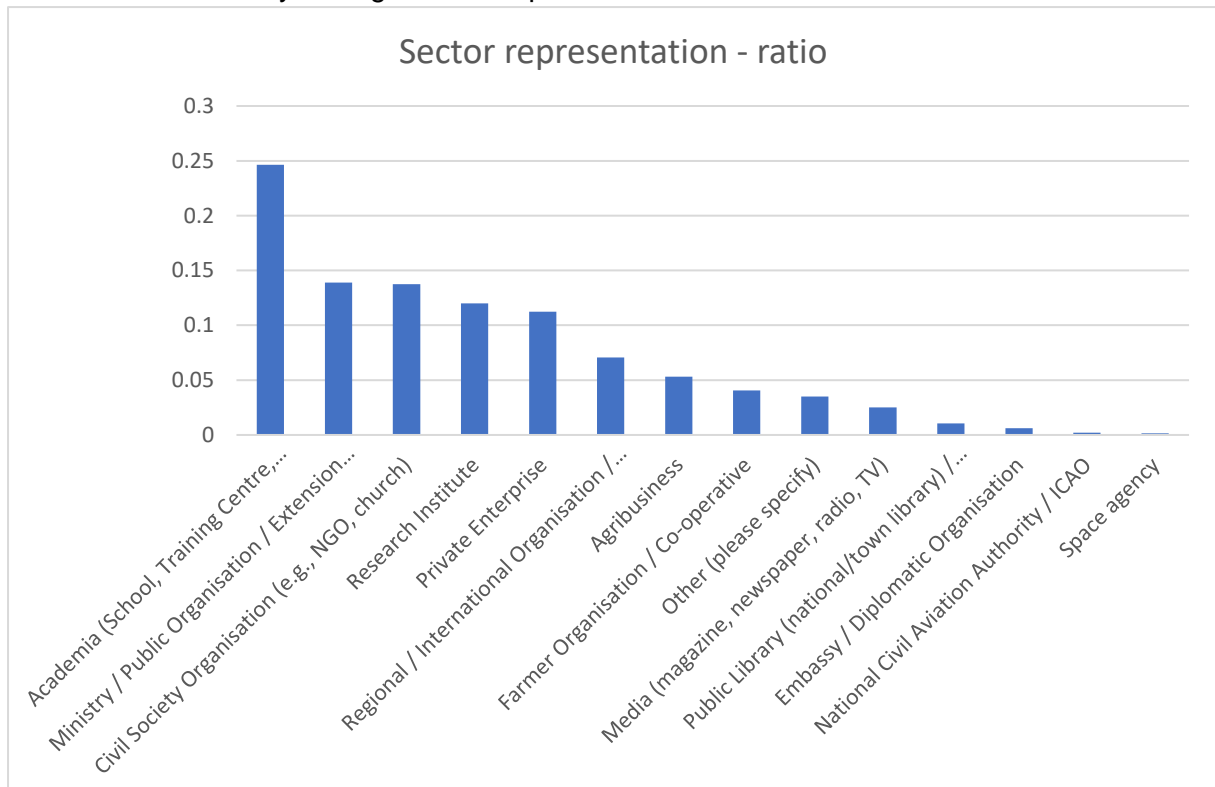
2.4 In which region or regions do you mainly work?



3 Organisation background

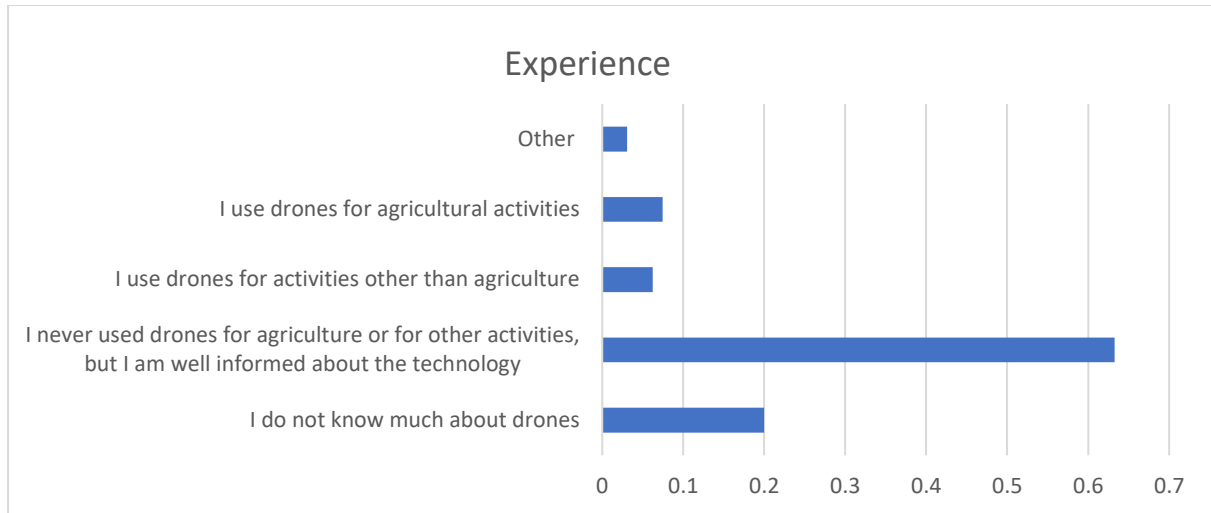
3.1 Which best describes the type of organisation you work for?

3.2 Sectors in which your organisation operates?



4 Experience

4.1 Please select the statement that best matches your experience with drones



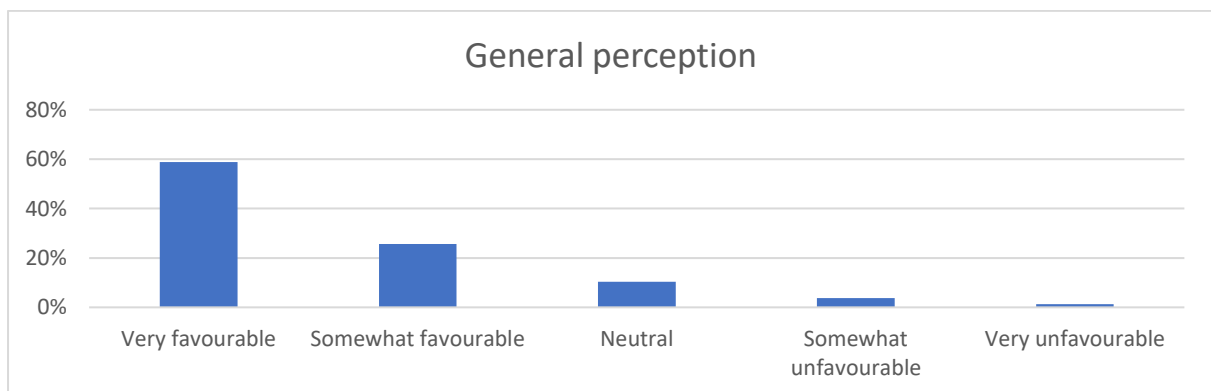
5 Experience details

5.1 I have used and or made use of drones

5.2 Please summarise briefly your experience using drones, including the context and the scope

6 Perceptions

6.1 In general, how do you view the use of drones in agriculture?



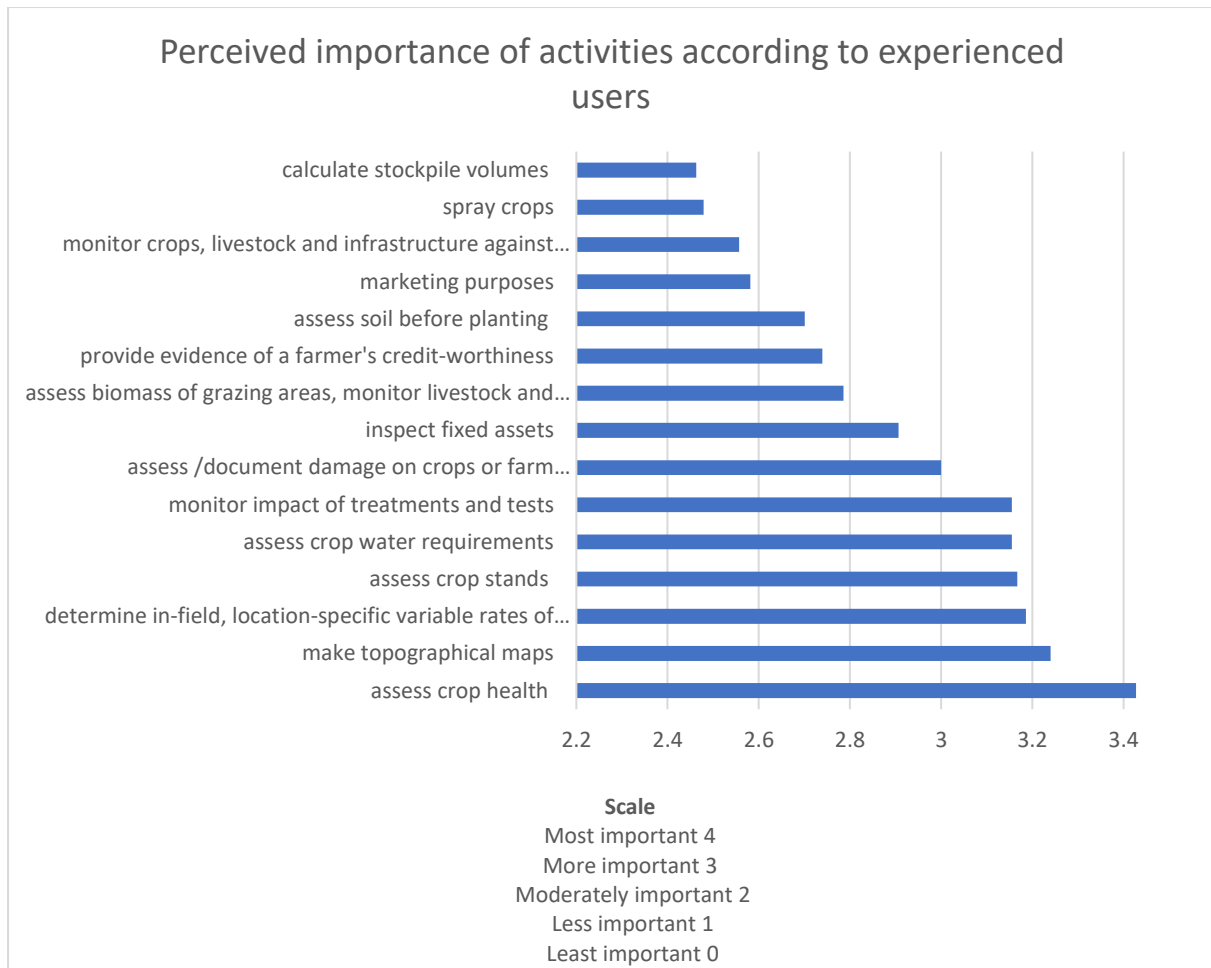
6.2 Please explain in a few sentences what has influenced your opinion (please provide examples):

Expensive Speed Experience Place Effective Vegetation
 Aerial Learn Agricultural Production Idea
 Farmers Accurate Data
 Drones in Agriculture Capture
 Technology Climate Change Crop Faster
 Data Collection Small Scale Farming Reduce
 Studies Decision Making Reliable Survey Work Easier
 Farm Activities Large Area

Gain de Temps Drones Permettront D'avoir
 Drones Permettent Mieux Connaitre Champs
 Photographie Aérienne C'est Capacité Surveillance
 Main D'oeuvre Données Optimisation
 L'utilisation des Drones Engrais
 Agricole Fournir L'agriculture Être un Outil
 Technologie Vision Cultures Attaques D'insectes
 Rapide Pays Africains Vue Évaluation des Superficies N'ai Jamais

7 Applications

7.1 According to your experience, please rank in order of importance the following services that drone-based systems can offer in the context of agricultural operations. 'Drone-based systems' include the drones, the sensors, the software or algorithms needed to interpret the captured images.



8 Opportunity

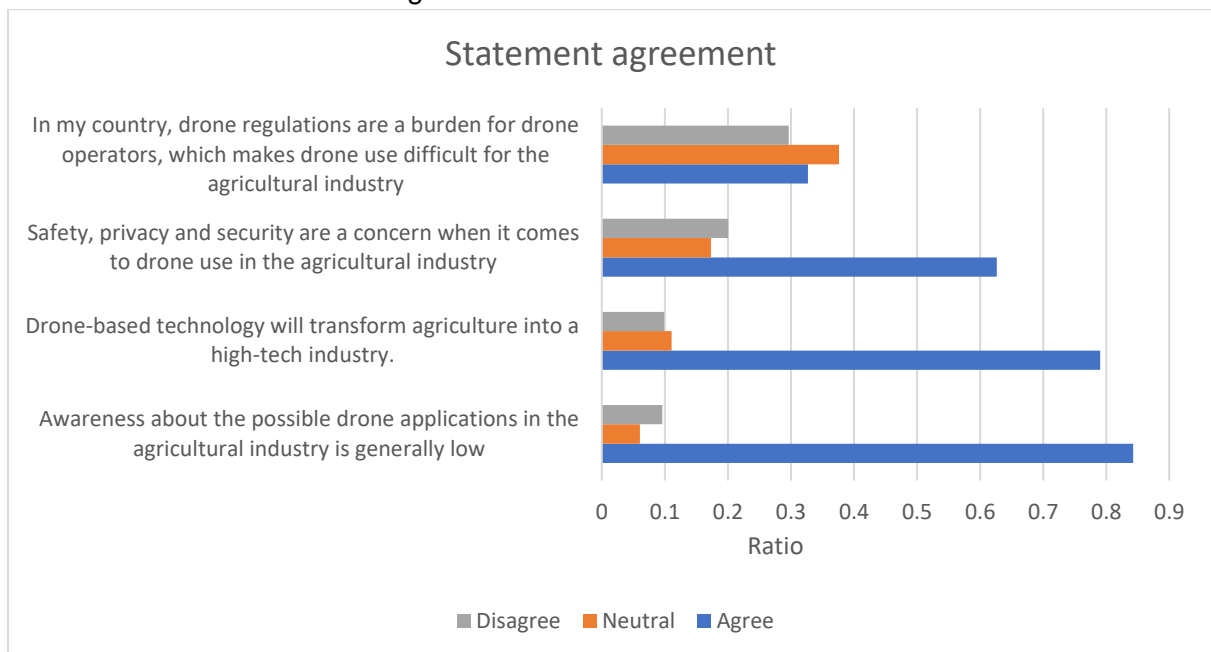
8.1 Where do you see most opportunity to use drones in agriculture?



Pesticides Superficies Question Prévisions Cartographie
 Plantations Pays Domaine Surveillance
 Besoins en Eau Zones Sais Cultures
 Recherche Afrique Idée Agricoles Agriculture
 Sols RAS Drones L'irrigation L'agriculture Santé Oui
Besoins des Plantes Partout Europe

9 Issues and potentials

9.1 Please react to the following statements:



9.2 Please provide one or more specific examples of where you see potential problems or issues regarding the use of drones for agriculture:

Technical Fly Policy Military Problems Misuse Privacy
 Services Country Land Security Access Cost
 Crop Technology Monitoring Farmers
 Control Agriculture Regulatory Regulations Air
 Farms Flight Awareness Operating Drones

Faut ^{Main} Sécurité Signaler D'un Sais Agricoles
 N'en Utilisation Traitement Pays RAS
 Technologie Cultures Drones Espionnage
 Problème Pesticides Coût Idée Privée Produits
 Afrique Moment Moyens Développement du Terrorisme Zones

10 Your feedback

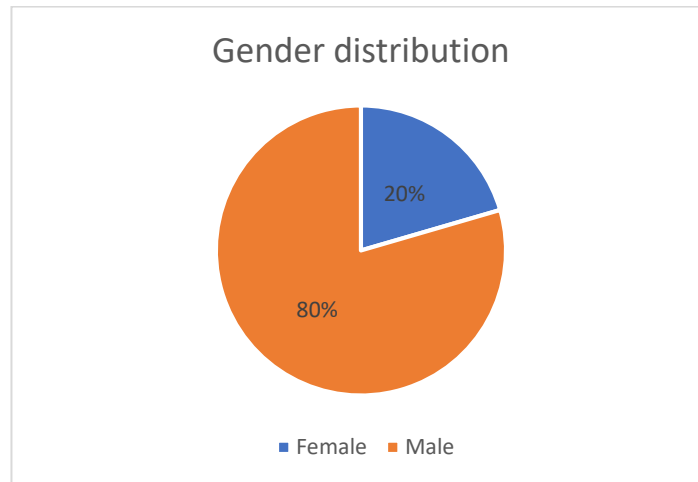
10.1. Please share any other thoughts, observation, and recommendations with us.

Forward ^{Good Innovation} Policy Makers Initiative Survey
 Regarding African Countries Uganda
 Regulations Workshops
 Developing Countries Nigeria
 Drones in Agriculture Short
 Technology ^{Place} Farmers ^{Security Issues}
 Education ^{Nil} Awareness Creation ^{Avoid}
 Idea ^{Discussion} Share ^{Remote Areas} Expensive Land

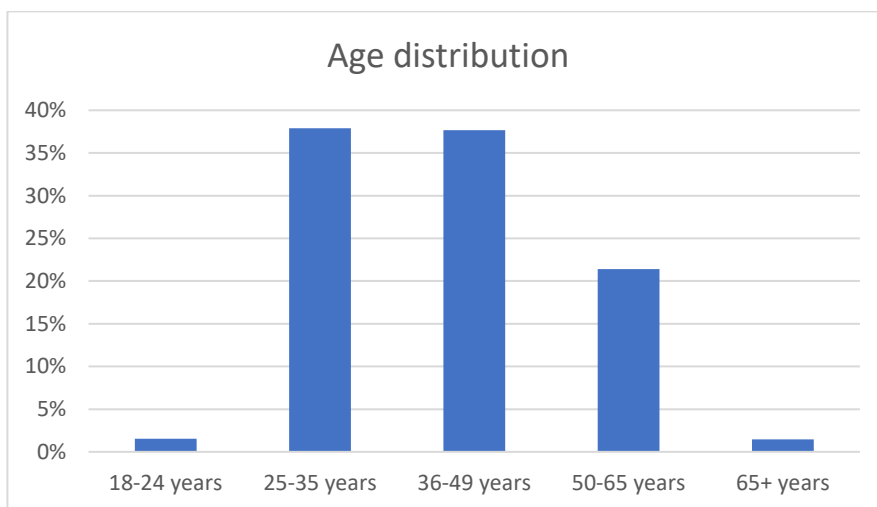
L'usage des Drones ^{Faire Bénéficiaire} Données Pesticides
 Idée D'autres RAS D'une Importance Agricole
 Traitement Pays Renforcer Les Capacités
 L'agriculture Signaler
 L'utilisation des Drones Davantage
 Technologie ^{Petits Producteurs} Formation
 Produits Drones en Agriculture Terrain
 Moment ^{Technique} Merci ^{S'avère Important} Paysans Prix

Annex 2: Graphical responses summaries for Africa only

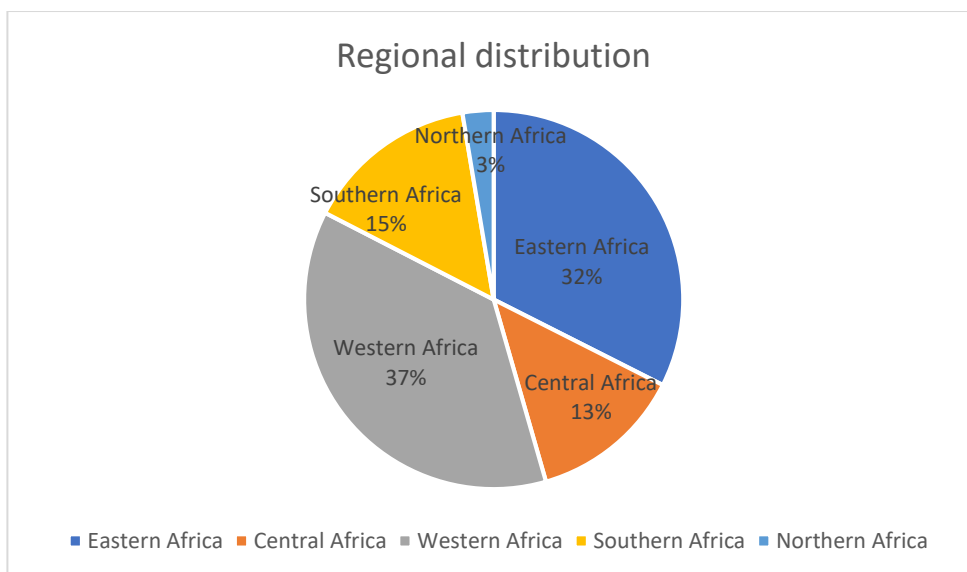
Most of the data only varies from the global data by a fraction of a percent and is thus not listed again in this African summary.



	Count	Percent
Female	266	20%
Male	1032	80%
Grand total	1298	

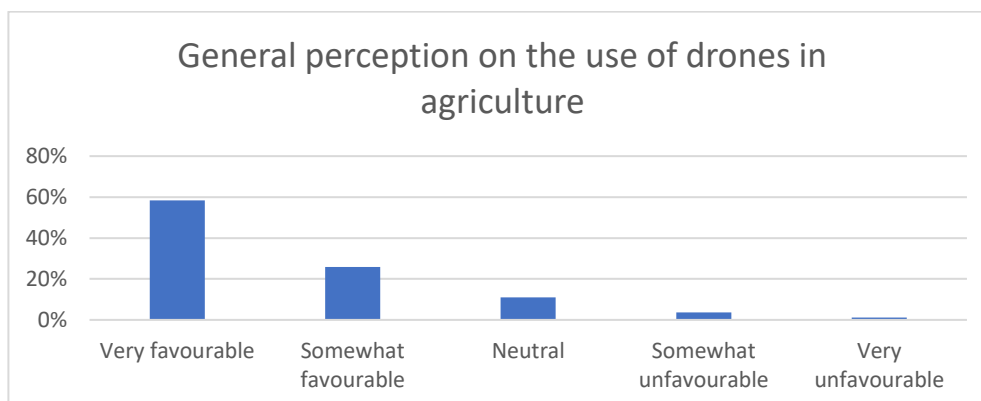


	Count	Percent
18-24 years	20	2%
25-35 years	492	38%
36-49 years	489	38%
50-65 years	278	21%
65+ years	19	1%
Grand total	1298	



Eastern Africa	441
Central Africa	178
Western Africa	503
Southern Africa	201
Northern Africa	36

Note: the low response rate in Northern Africa is related to the fact that the invitation to complete the questionnaire was sent to CTA recipients of CTA publications and members of CTA networks which include individuals mainly from East Africa, Central Africa, West Africa and Southern Africa, Caribbean, Pacific and Europe.



	Count	Percent
Very favourable	758	58%
Somewhat favourable	335	26%
Neutral	142	11%
Somewhat unfavourable	48	4%
Very unfavourable	15	1%
Grand total	1298	

The Technical Centre for Agricultural and Rural Cooperation (CTA) is a joint international institution of the African, Caribbean and Pacific (ACP) Group of States and the European Union (EU).

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