# COVID-19 IMPACTS ON INDIGENOUS FOOD SOVEREIGNTY, LIVELIHOODS AND BIODIVERSITY, GUYANA

# Covid-19 impacts on Indigenous food sovereignty, livelihoods and biodiversity, Guyana

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# SECTION 1. LESSONS LEARNED & RECOMMENDATIONS

The Covid-19 pandemic highlighted the importance of traditional knowledge and Indigenous farming for food security in the North Rupununi, Guyana. More people turned to farming for survival and there was a resurgence in interest and reliance on traditional knowledge about farming.

Prior to 2020-2021, the North Rupununi was on a dangerous trajectory of increased deforestation rates. The drier weather, combined with significant development incentives, had resulted in deforestation peaking at an estimated 1,701 hectares for the 2019-2020 dry season. The radical change in political, climatic and pandemic-related circumstances of the 2020-2021 dry season results in a drastic drop in deforestation rates to an estimated 277 ha – just 16% of the levels seen in the previous dry season.

Longer term trends in farming show that fallow times have shortened and more farms are being cut in secondary forest or old farms 'minabs'. There needs to be greater awareness raising of this trend towards short-term rotations and its long-term consequences for carbon sequestration and forest diversity.

At the same time, farmers are using fewer varieties of the staple crop, cassava, than in the past. This drop in cassava varieties has significant implications on the ability of Indigenous communities to cope with future crises events, and needs urgent attention.

Indigenous communities require greater agricultural advice and support, capacity building and help with marketing that builds on traditional knowledge, Indigenous culture and cassava diversity. Government assistance needs to be continuous and work through community structures so that farmers know what and how to get help.

Indigenous communities need more culturally appropriate information about crises events, such as the Covid-19 pandemic, that aligns with Indigenous livelihoods and worldviews, and where Indigenous peoples themselves can frame their responses.

Land tenure is critical for food sovereignty and biodiversity. Having legal tenure helps Indigenous peoples to secure resources and land needed to cope with pandemics, in which sustainable land management and practices can be governed and self-determination can be promoted.

# SECTION 2. INTRODUCTION

Covid-19 has had an unparalleled impact across the globe. Amongst the stories we hear, there is little about Indigenous communities living in biodiversity-rich, and frequently, remote areas of the world, and the ways they have been impacted and responded to the pandemic[1]. An ongoing Darwin Initiative project "Integrating Traditional Knowledge into National Policy and Practice in Guyana"[2] highlights the importance of Indigenous rotational farming, also termed swidden agriculture, for culture, livelihoods and biodiversity, and anecdotal evidence suggested that many Indigenous communities in Guyana turned to traditional farming to survive during the pandemic.

Swidden agriculture is found across the humid tropics in South America, Africa, Asia and Oceania[3,4], and it is estimated that 200-300 million rely on this form of agriculture for their livelihoods[5]. For Indigenous communities, itis not just an agricultural technique, but an integral part of their way of life[6]. This traditional form of agriculture within forest environments improves soil water and nutrient retention, reduces erosion and degradation, increases agrobiodiversity, reduces carbon emissions, and enables carbon sequestration through biochar[7,8]. At the same time, traditional food systems reinforce collectiveness, Indigenous knowledge and the adaptive capacity of local people to experiment and solve their own problems.

**Villagers harvesting cassava from their farms.**

However, climate change, population increase, and government and conservation policies have caused a shift to a shorter fallow period which has intensified cultivation on the land[9,10,11,12,13]. The consequences of this change have been deforestation, soil degradation and soil nutrient depletion, with less mature secondary regeneration leading to less biomass accumulation and carbon sequestration, low biodiversity and poor soil protection[14,15]. At the same time, traditional knowledge is being lost. This is the result of intergenerational loss due the decrease of elder community members, an increase in incomplete transmission of knowledge as there is less information on skills and practices available to the mature population, and a decrease in intergenerational transfer between older and younger people. In Guyana, for example, the influence of formal schooling and the church has been a significant factor in changing peoples' perceptions of traditional practices[6].

This report presents work from a Darwin Initiative Covid-19 Rapid Response grant that ran from January to March 2021 in the North Rupununi, Guyana. With a long-term aim to enhance Indigenous food sovereignty and agroecological knowledge that sustains livelihoods, culture and biodiversity, we were interested in exploring how Indigenous communities have been impacted by and responded to the Covid-19 pandemic. More specifically, we looked at local livelihoods, leadership, and if/how farming activities changed, and their potential impacts on forest cover and biodiversity.

**Swidden farm being prepared for planting.**

# SECTION 3. METHODS

## 3.1 Research background

In this research, we drew from the Indigenous methodological approach taken in 'Integrating Traditional Knowledge into National Policy and Practice in Guyana" project where research processes and practices take Indigenous worldviews, perspectives, values and lived experience as their central axis. We aimed to collect data that met Indigenous needs and aspirations, and reflected the embodied social, political, historical, and cultural realities of Indigenous people's lives. The research was shaped by strong and long-term collaborations with Indigenous communities in the North Rupununi, and their representative organisation (and partner in this project), the North Rupununi District Development Board (NRDDB).

Indigenous senior researchers of the NRDDB contributed to the design of the research, and at a practical level, led the research activities in the communities. This involved established Indigenous senior researchers, who had prior and extensive experience of participatory research in their communities, and authors of this report, organising and facilitating workshops, and carrying out data collection. They worked directly with trained community researchers in each village, and synthesised video material for non-Indigenous audiences.

We worked directly with Makushi and Wapichan community members from the North Rupununi villages of Annai, Apoteri, Aranaputa, Crash Water, Fair View, Kwatamang, Massara, Rewa, Rupertee, Surama, Wowetta and Yakarinta (approximately 235 people) (Figure 1). We used four methods as follows:

1) an established household farming survey to assess changes in farming practices between 2012 and 2020-21 Covid-19 pandemic year;

2) participatory video to explore the positive and negative impacts of Covid-19 on local livelihoods;

3) satellite radar change detection analyses to estimate the type and extent of deforestation from the 2017-2018 to the 2020-21 dry seasons (the latter comprising the Covid-19 pandemic year);

4) video-mediated dialogue with relevant government agencies and the communities to assess responses and actions, and links to current and future policy priorities.

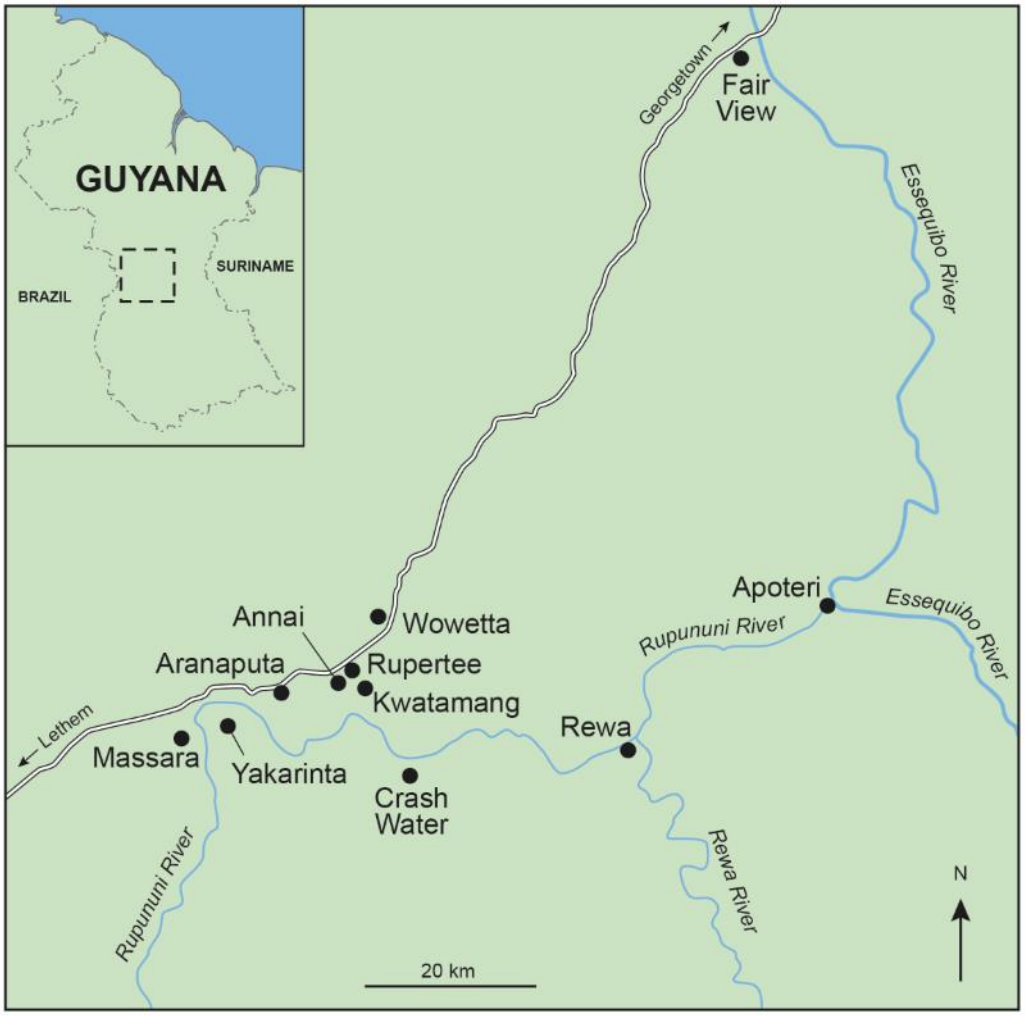



*Figure 1. Map showing location of communities directly working in the research.*

## 3.2 Household farming survey

We used an established household survey about farming that was developed by the Makushi Research Unit of the NRDDB as part of a Community Monitoring, Reporting and Verification (CMRV) REDD+ process in 2012. The survey contains questions on farm size, types, patterns, crops, economics, threats and challenges, importance to families and communities. This survey was adapted to include extra questions about farming responses to Covid-19 (see Appendix 1).

The survey questions were formatted to work with the ODK data collection app. Working with community data managers trained by the CMRV project, the questions were formulated with answer options to ensure the same options were available as per the previous survey. The forms were then uploaded to smart phones to conduct the surveys in the communities. We worked with 15 community resource environmental workers (CREWs) to collect the data. CREWs were asked to re-interview available participants from the previous surveys to allow comparisons between the survey years. Before returning to their

communities', time was spent reviewing the interview checklist to clarify any potential questions.

Household surveys took place in Annai (n=41), Aranaputa (n=11), Crash Water (n=14), Kwatamang (n=15), Massara (n=16), Wowetta (n=44) and Yakarinta (n=15). From the 156 respondents, 87 were male and 69 were female.

Permission was sought from the NRDDB to obtain the data from previous surveys. These had taken place in 2012 and in 2018. This data, together with the 2021 data, was first cleaned, collated and verified for anomalies and missing information. For questions where it was possible to compare 2012 and 2021 data, namely for the villages of Annai, Aranaputa, Crash Water, Kwatamang, Massara, Wowetta and Yakarinta, analyses were undertaken using simple descriptive statistics to identify trends and patterns of change.

Not all survey questions were answered by all respondents. One of the problems we encountered during fieldwork was locating the community members that had previously been trained in the use of the survey data collection app. These CREW members had not used the survey data collection app for a few years, and so needed some re-training. However, due to Covid, group meetings were still limited during the project period, so there were few opportunities to train them which resulted in some survey responses being inconsistent / incomplete. In addition, the smart phones used for collect data previously were no longer in working order and CREWs had to use their personal phones for the surveys. This created compatibility issues in terms of the software needed to carry out the surveys and the ground truthing activities (Section 3.4), resulting on only land use verification occurring and helping to verify area size of disturbance.

## 3.3 Participatory video

After further consultation with the NRDDB, participatory video was used to focus on:1) farming and Covid-19; the impact of Covid-19 on people, community life and traditional knowledge, and; leadership during the pandemic. Participatory video was facilitated by experienced Indigenous senior researchers of the NRDDB in the villages of Aranaputa (n=7), Annai (n=13), Rupertee (n=13), Kwatamang (n=10), Apoteri (n=8), Fair View (n=9), Rewa (n=7) and Wowetta (n=12). From the 79 storytellers, 32 were male and 47 were female.

The Indigenous senior researchers helped to design an interview checklist (Appendix 2), and in each community they worked with community researchers trained through the 'Integrating Traditional Knowledge into National Policy and Practice in Guyana" project, as well as the wider community. In each community potential resource persons were approached; the project was explained, and they were asked if they would be willing to participate and answer some questions. Some storytellers were able to participate immediately, in other cases appointments were made for another time that was convenient. In some instances, the community researchers were able to make visits with the farmer to their farms.

**Senior Indigenous researcher Rebecca Xavier doing participatory video.**

The editing of the videos was completed by the Indigenous senior researchers. Drafts of final videos were screened back to the communities for final comments and changes, and to obtain final consent for sharing and distribution. The three final participatory films can be found here:

The impacts of Covid-19 on Indigenous farming:https://communityownedsolutions.org/video-post/the-impacts-of-covid-19-on-indigenous-farming/

Impact of Covid-19 on community life: https://communityownedsolutions.org/video-post/impact-of-covid-19-on-community-life/

Leadership during the Covid-19 pandemic: https://communityownedsolutions.org/video-post/leadership-during-the-covid-19-pandemic/

Over 20 hours of footage were collected and transcribed. Our data analysis of the participatory videos looked at the emergence of dominant narratives and themes from the visual and audio materials. It is important to note here that in our analysis we were not seeking to produce a harmonious and homogeneous representation from the Indigenous participants, but recognising the unavoidable tensions between perspectives, and maintaining, rather than erasing differences.

We then screened the videos to the seven Indigenous communities, leaders of Indigenous associations in the region, namely the NRDDB, Kanuku Mountains Community

Representative Group (KMCRG) and the South Rupununi District Council (SRDC), the Ministry of Amerindian Affairs (MoAA) and the Ministry of Agriculture (MoAgri). The aim of the screenings was to open a dialogue between communities and decision-makers on community issues/concerns and ways in which decision-makers could support communities – both short-term and long-term.

### 3.4 Satellite radar change detection of forest cover

As optical satellite imagery is not reliable in tropical regions due to persistent cloud cover, for this part of the work, we have used Synthetic Aperture Radar (SAR) imagery as its active nature (non-dependency of external sources of light) allow it to penetrate cloud cover. In particular, we have used Sentinel-1 mission imagery, which was launched in 2014 by the European Space Agency (ESA), and is recognised as one of the most successful remote sensing missions since its open-user policies, global coverage, high spatial (up to 10m) and temporal resolution (revisit time up to every 3 days) has revolutionised remote sensing environmental monitoring.

For the Sentinel-1 image analysis, we used SAR-CUSUM - a novel forest cover change-detection tool which we recently developed for identifying logging activities in temperate forests[16]. Our SAR-CUSUM algorithm uses the Cumulative Sum statistical method for identifying anomalies in the radar signal values over time. The use of dense time series of Sentinel-1 images allowed us to continuously monitor forest change in the North Rupununi during our study period.

The study of forests using radar images can be a challenge. Forests are highly dynamic ecosystems and the identification of structural disturbances will depend to a greater extent on a wide number of forest variables such as typology, phenology, and the dynamics of these ecosystems. A preliminary exploration of the radar signal time series over the North Rupununi served to provide us with a first idea of the potential capabilities of the SAR-CUSUM method. As shown in Figure 2, forest areas showed a great signal stability throughout the year when compared to non-forest areas. Contrary to the high radar signal variability generally observed in temperate forests dominated by deciduous species, the very stable behaviour observed for our region of study responds to the high and dense canopy cover, and a less marked seasonality, typical of tropical forests. Regarding the most suitable polarization channel, we found the VV channel as the best polarization to investigate forest disturbances since it showed a greater signal stability for forest regions.


*Figure 2. Forest vs Non-forest radar signal comparison. Time series of Sentinel-1 images acquired from 16th May 2016 to 1st January 2021.*

These preliminary findings provided us with sufficient confidence to guarantee a correct performance of our SAR-CUSUM method since any sustained forest change over time will result in a significant variation in signal.

Special attention has been paid to seasonality when developing our analysis. Considering the particularly high dynamism of the Rupununi region, we had to consider the potential influence that seasonal changes may exert on the detection analysis. The analysis of the images acquired during the wet season could lead to important classification errors associated with the environmental changes that occur during this period (e.g., temporal floods). At the same time, most forest disturbances occur during the dry season months, in which the better state of roads and infrastructures, allow better access to the forests for their use, and the principal tool of deforestation, fire, can be readily applied. For these reasons we decided to focus on the change detection study using the images acquired during the dry season.

The exploration of the preliminary values obtained for the cumulative sums for various forested areas helped us to identify a slight variation in the radar signal. This signal variation, commonly known as 'random noise', is characteristic of vegetated surfaces and is usually caused by random variables such as wind or temperature. Since our primary objective was not focused on developing a near-real-time monitoring tool, we decided to work with monthly composites, thus minimizing the possible influence that this random signal variation could have on the final detection performance (see Figure 3).

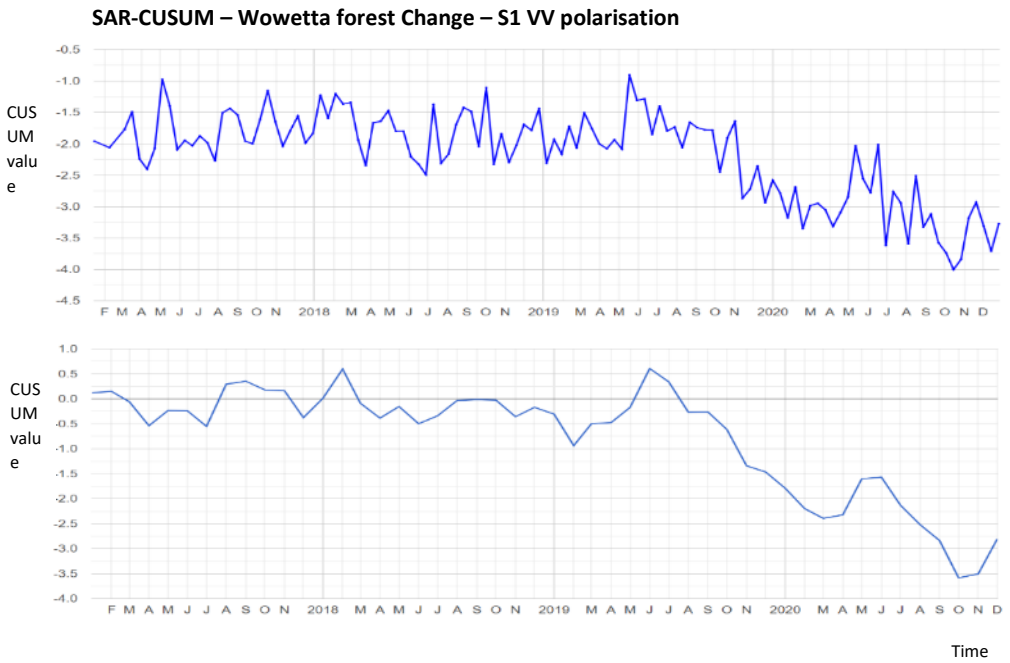



*Figure 3. Comparison of the cumulative sums values for time series composed of daily images (every 12 days) (Top) and monthly composites (Bottom). The study area corresponds to a forest plot near Wowetta, which was deforested in November 2019.*

To focus the analysis exclusively on forest areas, we masked out all non-forest areas, using the Tree Cover Map generated for the year 2000 by the GLAD-Hansen Global forest map (see Figure 4).

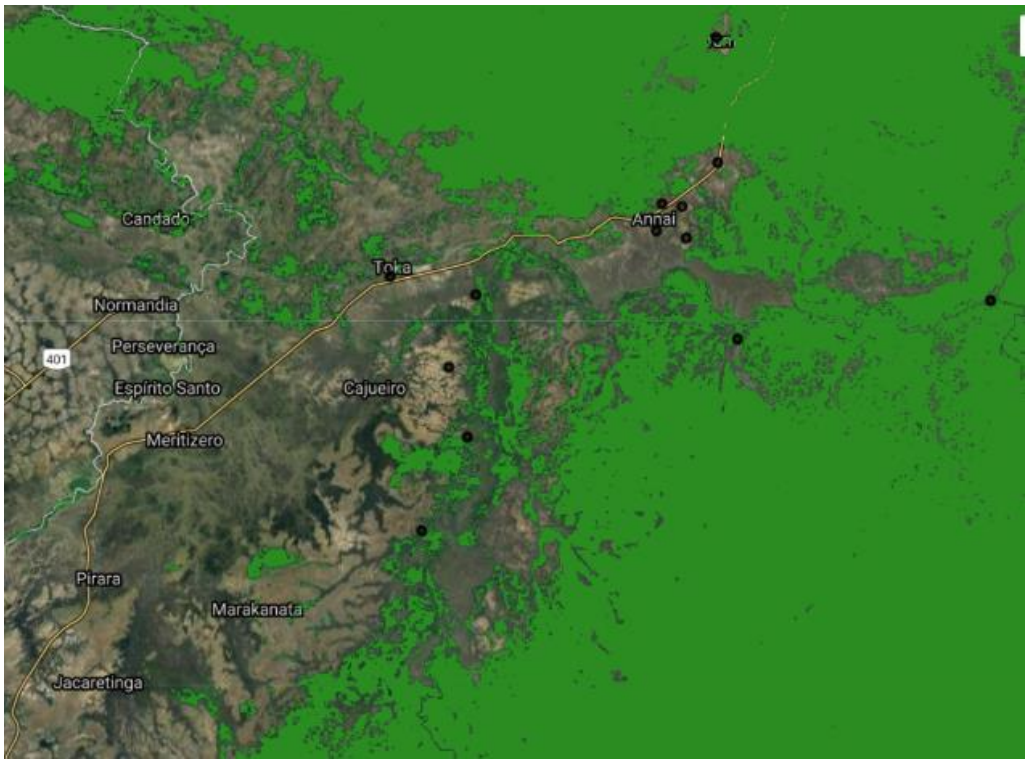



*Figure 1. Screenshot of the Global Forest Map – Tree cover 2000 (canopy cover >90%), in green, used for mapping out all the non-forest areas.*

Once the cumulative sum values were calculated for all pixels located in forest areas, we proceeded to investigate the CUSUM trend for areas with known recent disturbances. For this, we made use of optical cloud-free high-resolution (3 m spatial resolution) images acquired by Planet. These images allowed us to analyse the radar signal response in form of CUSUM values in recently deforested areas, thus allowing us to set the detection thresholds for identifying forest change. Figure 5 illustrates two examples of forest changes detected by the automatic CUSUM-SAR approach matching the disturbances observed in the high-resolution Planet optical imagery.


*Figure 5. SAR-CUSUM forest change detection examples and comparison with HR Planet optical imagery. (Top) New forest opening for farming, Annai region and (Bottom) extensive forest fire near Crash Water community.*

For the CUSUM results, there are two potential deforestation estimation 'errors' that then needed to be analysed: some areas identified as being deforested may in fact be false positives ('over-detection error'), while in some cases, the CUSUM algorithm may have actually failed to identify some areas where deforestation has actually taken place ('under-detection error'). In order to address the over-detection issue, the GIS layer polygons for all the deforested areas were imported into QGIS and each individual polygon was assessed against the Planet imagery for that year and against higher resolution Bing imagery from pre-2017. This enabled us to identify whether the polygon was a false positive as a result of anomalies within the Goggle Earth Engine analysis emerging from co-registration discrepancies (Figure 6). This allowed us to eliminate over-detection polygons in the total deforestation estimates for each year. More importantly, the Planet analysis allowed us to identify the nature of deforestation i.e. whether it had emerged as a result of farming (Figure 7), wildfire (Figure 8) or road construction/widening/logging operations (Figure 9).

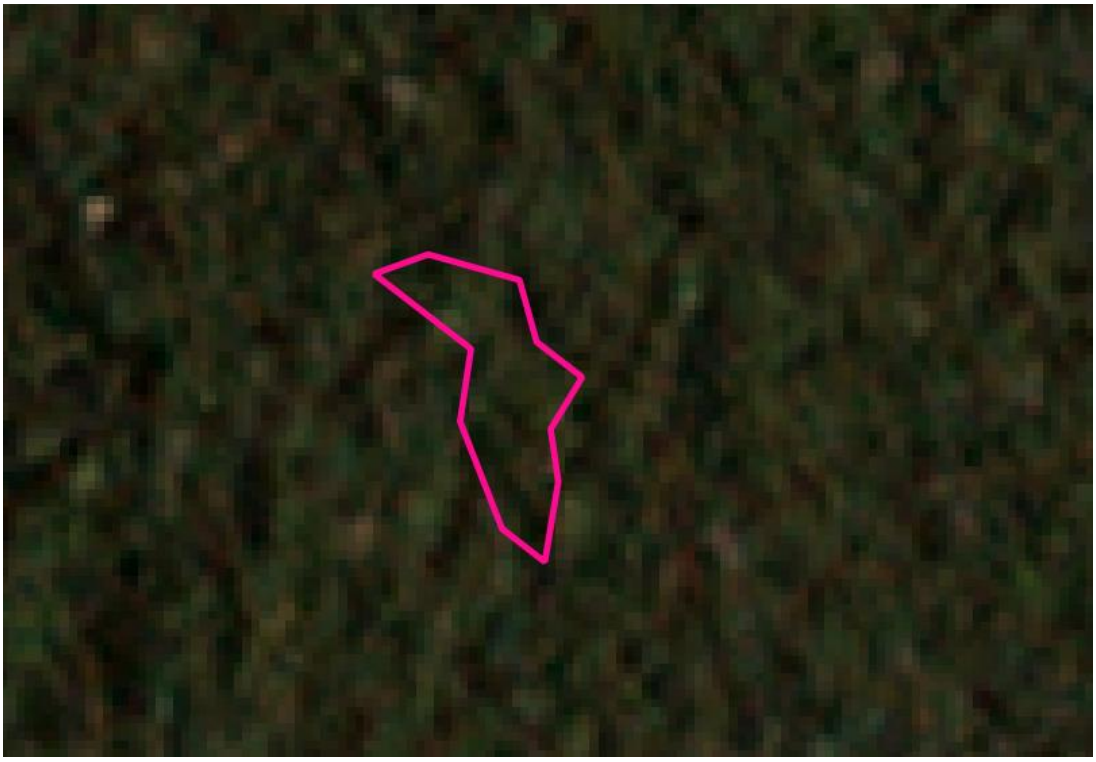


*Figure 6. An example of a CUSUM deforestation polygon false positive identified through comparison with Planet imagery.*

*Figure 7. An example of a CUSUM deforestation polygon resulting from farming as validated through comparison with composite Planet imagery.*

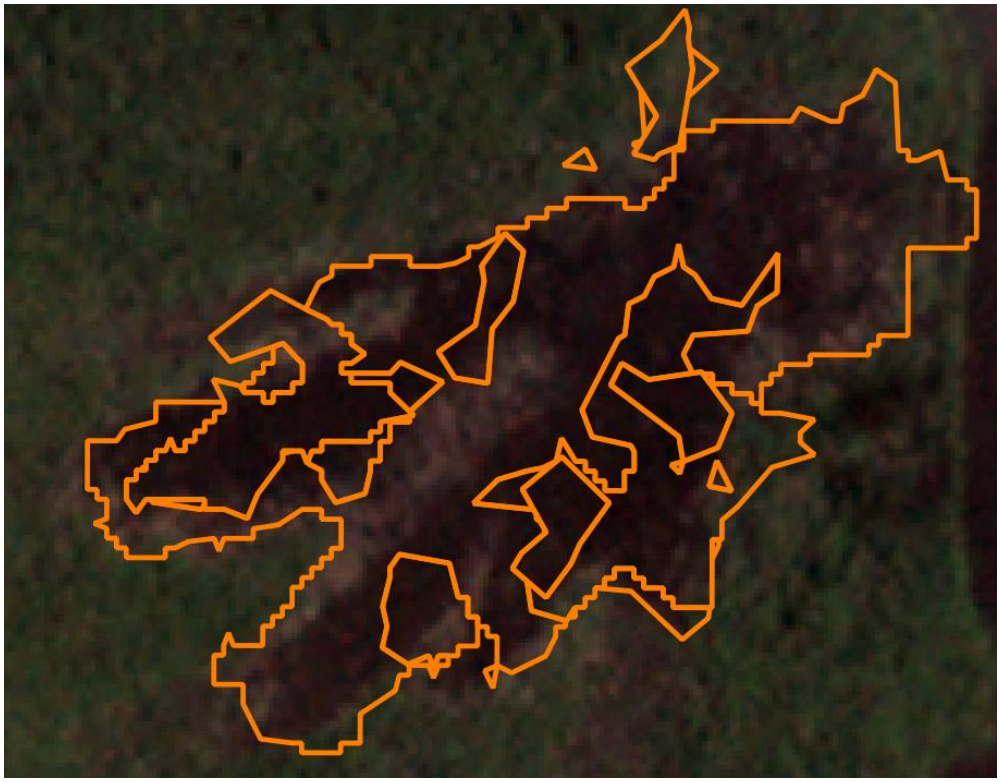


*Figure 8. An example of CUSUM deforestation polygons resulting from wildfires as validated through comparison with composite Planet imagery.*

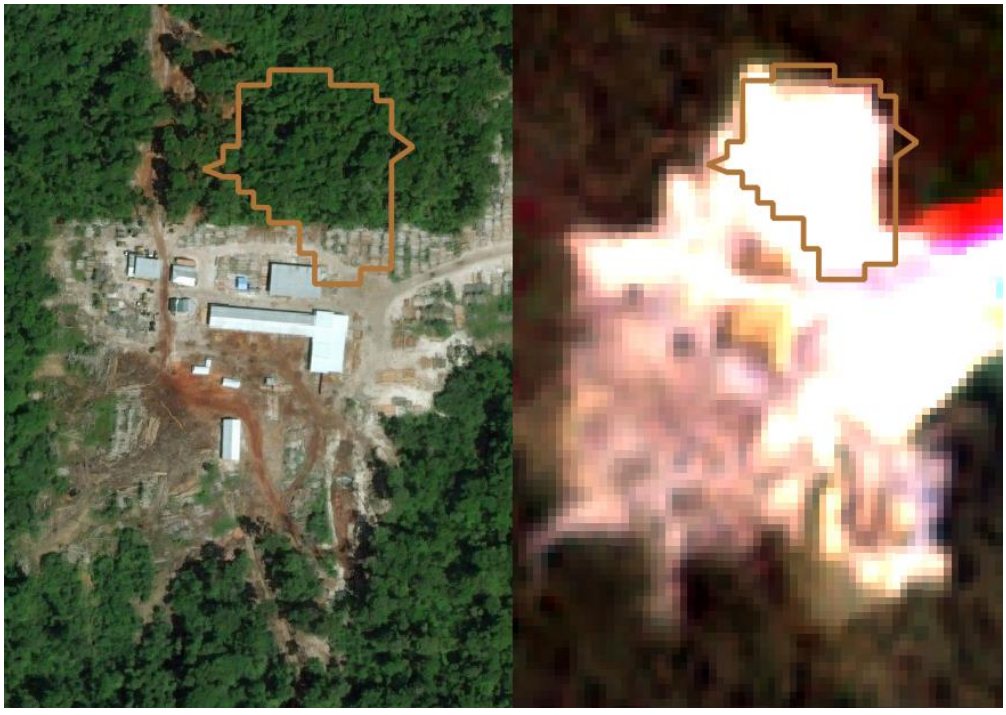


*Figure 9. An example of a CUSUM deforestation polygon resulting from logging operations within the Iwokrama Forest. The image is a comparison between higher-resolution imagery from Bing Maps (pre-2017) and the Planet composite image from June 2019.*

Resolving the under-detection challenge was more difficult. A ground-team did undertake a field campaign to map as many recently deforested areas as they could achieve within the time limitations, resources available and Covid-related travel restrictions. 34 recently deforested sites were mapped and GPS coordinates for these were imported into QGIS for comparison with CUSUM polygons to see if the latter had missed out any areas (see examples in Figure 10). Comparisons show that all the 34 sites had indeed been picked up by the CUSUM change detection. However, comparison with Planet imagery does suggest that some under-detection has occurred. Thus, a more detailed and comprehensive ground-truthing campaign, monitoring deforestation over extensive time periods and in different habitat types, needs to be undertaken in order to accurately assess the level of under-detection.

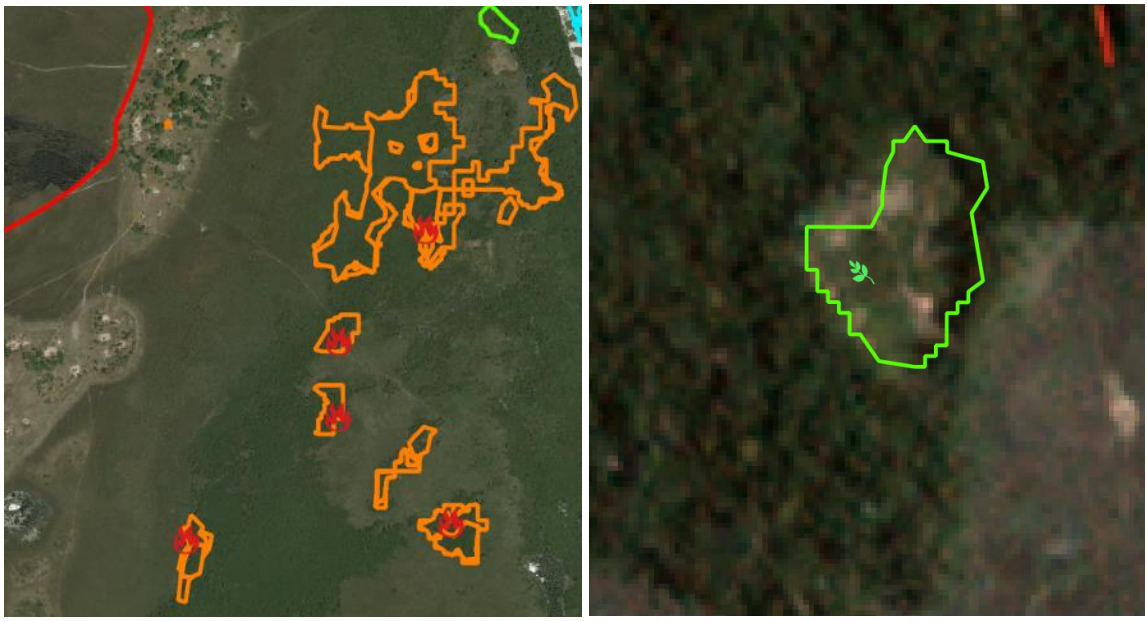


*Figure 10. Comparison of CUSUM deforestation results (orange polygons indicating deforestation as a result of fire, green polygons indicating deforestation as a result of farming), with ground-truthing (red flames indicating where the team marked deforestation areas as a result of fire, while green leaf indicating deforestation areas as a result of farming).*

## 3.5 Ethics

We followed the Right of Free, Prior and Informed Consent (FPIC) processes stated in the 2007 United Nations Declaration on the Rights of Indigenous Peoples. Our Ref. 24-026 Guyanese permit and health and safety risk assessment was reviewed and updated in line with project activities and Covid-19 measures. In addition, the research underwent a full ethics review at Royal Holloway University of London (UK). Participants were thoroughly informed of project details, including aim, methodology, conditions of participation and intended output distribution. A visual consent form - outlining project details, conditions of participation and intended output distribution - developed by the Indigenous senior researchers was used.

We established data management protocols through the FPIC process. No personal data beyond name, age and village was collected. Data is owned by the communities in which they were obtained, with storage and access negotiated and agreed at the start of the project. Participants could request for any video recordings made of them to be deleted without requiring justification. Our screenings of video material to individuals and within communities aimed to ensure the highest standards of editing ethics, representation and informed consent. Video footage was first broadcast within the contributor groups, and then permission sought for broadcasting to other stakeholder groups and for inclusion online. All materials agreed by the Indigenous communities to be publicly available is licensed under the Creative Commons "Attribution Non-Commercial No Derivatives" protocol. This stipulates that any distribution of original material will need to have the original authors cited, the material cannot be used for profit-making purposes, and the material cannot be modified/edited/remixed without the consent of the original contributors.

All necessary travel and subsistence costs for participants were covered by the research funds. Community researchers were paid stipends commensurate with local salary scales and agreed by village toshaos and councillors.

The Guyanese project team members assessed health and safety, with a specific focus on Covid, working closely with village leaders on safety measures and access. In line with Indigenous customs of communal provision and sharing of food at events, but with Covid safety measures in mind, we provided snacks but this was done at the end of the session as people were leaving to go home. Each screening took place in the evening to allow for use of outdoor venues and to facilitate social distancing. Sanitiser and masks were provided at all meetings and screenings to ensure everyone’s safety.

# SECTION 4. RESULTS AND DISCUSSION

## 4.1 The impact of Covid-19 on local lives and livelihoods

When the pandemic hit the Indigenous communities in the North Rupununi, many people were not clear what Covid was "*It was very bad. My partner couldn't eat at all. We did not know what it was even though people were talking about it*" (Female elder, Annai). Hearing about the symptoms, many people believed they had Covid but were not tested, so although they might have had Covid, it could also have been other common illnesses such as dengue and malaria. Although there were the immediate effects of getting sick, people carried on with daily life as recalled by this woman from Annai Central "*Suddenly I started to get high fever, headaches, shortness of breath. But I was strong, I was able to overcome it. After that I did not taste anything, didn't smell anything. Even though I was suffering with this, I manage to parch my farine*". At the same time, feedback from screenings revealed that individuals who contracted the virus were (in some cases) shunned during their period of sickness and even after. This was due to lack of information and associated high degree of fear of the virus, indicating the need for greater awareness at the community level.

However, once the lockdown was instated, the gravity of the situation became apparent. Table 1 shows the main themes coming out of the participatory videos on the impact of Covid on local lives and livelihoods. Many people moved from the village to their farms or 'backdams' to wait out the pandemic. The survey data shows that 63% of respondents had dwellings in their farms in 2021 compared to 40% in 2012. Almost half the households in the Rupununi region are involved in wage labour, in sectors jobs such as labourers, miners, teachers and within tourism[17]. With the immediate closure of schools and businesses and the lack of jobs and paid work, farms were seen as the only support for communities. People turned to their traditional knowledge for farming, fishing and hunting, as well as for traditional remedies to prevent and help treat the symptoms of Covid.

Many of the storytellers mentioned the loss of paid work within the tourism sector. For example, the Iwokrama International Centre has an eco-lodge within the Iwokrama Forest where Indigenous community members employed as cooks, cleaners, guides and boat captains lost their work. Some villages have their own eco-businesses, such as Rewa, where tourism came to a stand-still. Other community members were supplying goods, such as craft, to eco-lodges and this also stopped. Thus, the paralysis of tourism had and continues to have a significant impact in the region, and potentially has a greater impact on women who have a greater presence in the tourism sector[17].

Communities reported that their own movement was restricted, and they could not see family members living in other villages and towns. This despite some private sector activities, such as mining, being allowed to continue and for miners to continue to travel through the region to designated mining sites in the South Rupununi.

*Table 1. Main themes associated with impacts of Covid from the participatory videos.*

| **Themes** | **Illustrative quotes** |
|---|---|
| Left village and moved to backdam / farm | "When I heard about it [Covid], I spent 9 months in the backdam".<br>"When I heard about it [Covid] for the first time, rumours said that you will get sick and everybody will die. So, we decide now that we don't want to catch the sickness, so we came to the backdam, I brought my family. We came and we are here for past six months". |
| Change to village / village life / socialising | "[in the village] sometimes you don't hear no one anymore, no music, nothing, like everyone die. They say where all the people and then you realise everyone in their farm, everyone move out".<br>"My neighbours were afraid of me, they were not visiting anymore like before, we were not gaffing anymore with our friends. Before they heard of Covid, everybody was socialising good". |
| Closure of schools and churches | "The parents are very concerned today that the children are not back in school, even though teachers are trying five times in a week to have a class". |
| Had to stop paid work e.g. tourism, logging, mining | "I usually go out and work for a month or two".<br>"I could not get to go back to Marudi [mining area] where I use to make my money".<br>"I does work with Iwokrama as a captain of the boat and I have been working for years with them. But the work there close because no tourist is coming due to Covid". |
| Affected local organisations e.g. peanut factory | "I was employed at the Aranaputa Peanut Butter factory. After Covid came, the schools had to close, a lot of businesses stop buying our stuff, so we had to close the factory. Right away there was a loss of income. It really affected the whole organisation". |
| Reliance on farm and farm produce | "I've been affected financially, but nevertheless my farm has supported me. I've planted cassava, vegetables, fruits, and that is how I maintain myself". |
| Reliance on traditional ways | "For me, it is not difficult [to deal with Covid] because I live this life. Not like them young people that want fancy things to put on their eyes, on their foot, they have to get this, and if they didn't eat that they don't feel good. Me, I live just like this, whatever I get to eat. If I eat just farine and salt, I satisfy as long I wake up next day. We old people not gonna feel it because we accustom with our farine and cassava bread". |
| Use of bush / traditional medicines to cure and prevent Covid | "After the people affected tested positive, we used a lot of bush medicine, together with some other stuff like ginger, garlic, limes, lemons, papaw leaves and so on, we tried a lot to save ourselves". |

| | |
|---|---|
| | "We were drinking plenty bitters. A lot of people used different traditional medicines".<br>"When we going up to Annai for supplies, we used the traditional medicine, we drink the bark that is bitter, we walk with it". |
| Greater connection with traditional knowledge | "In my community, many people depend on traditional knowledge to do farming, to do medicines, also traditional hunting. As Amerindian people we depend on our knowledge in order to survive. We will keep it and we will continue to do so because that is the only way we will survive".<br>"Covid 19 has changed my life from being that person I was before, to be more hardworking young lady, I am more willing now, I am not lazy to work in the farm. I get more access to older people, I get knowledge from them, I talk to them more. I ask them more questions about farming which I never did before". |
| Restrictions on movement | "I have a daughter in Georgetown, but we can't got to Georgetown, we can't go anywhere, nobody wants to take the chance". |
| Affected individual businesses | "I make handicraft and sell. This is how it [Covid] really affected me because no tourist you have today in the country. Business gone down flat". |

**The backdam.**

Nevertheless, the pandemic has also provided an opportunity. For example, some people are still living in the backdam, farming not only for family use but to make surplus for selling farine (see Section 4.2). They bring their produce out once a week to sell at the village shops and then return to the farm.

Although some people felt the lack of social life in the village, in many respects these aspects of village life moved to the backdam where social gatherings and sports events continued. Where people were still in the communities, such as in Wowetta, they created bubbles so that when there was a need for large groups only people in the bubble would be involved. This movement of people to the backdams, and having to rely on traditional ways allowed people to re-engage with their knowledge, and valorise the knowledge they and their community members, especially elders, hold. As stated by an Indigenous leader during a screening "[Covid] *also brings out the strength, especially in Indigenous people. Where we survive off of nature. Our farming systems are very intact; to farm we haven't lost that traditional knowledge of farming. So I guess in that manner it allows the youths to learn some of these skills, the craft. Although you might not be able to do it on a commercial base, you now have the time to learn these things. You have the time in hand to really learning back at home. Most of the homes if you check now are going back to their traditional knowledge*". The Ministry of Amerindian Affairs also acknowledged the importance of traditional knowledge "*Focusing on farming, what I see as the message is that traditional knowledge is very important to survival – not only farming, but also traditional medicine. This help to protect them. So traditional knowledge played an important role in helping them to overcome the pandemic*".

## 4.2 Trends in farming and the impacts of Covid-19

The participatory videos show that Indigenous farming activity increased from the start of the Covid-19 pandemic and associated lockdown during 2020 (Table 2, see Box 1 for the different stages and times of contemporary farming by the Makushi). More people turned to farming to sustain their lives, and in some cases, larger farms were cut.

*Table 2. Main themes associated with farming from the participatory videos.*

| **Themes** | **Illustrative quotes** |
|---|---|
| More people farming | "Since this Covid take place, it is an improvement in my life that I go out to my farm and do my farm work, cut more farm than what I use to before".<br>"I started the farming after Covid came in. You couldn't be going to work, you have to be at home so we started to go in the farm, with our aunt actually, started helping she out, and eventually starting a farm of our own".<br>"When Covid step in, nobody can move anywhere to buy anything, to bring nothing, so there and then everyone eye |

| | |
|---|---|
| | open and say how we gonna survive? We have to do farming. Everybody starts cutting farm".<br>"Almost everyone got farm now. We have a lot of farm than before, almost every household has a farm". |
| Bigger farms than before | "Now I have a bigger farm than before, like 5 acres". |
| Planting more diversity of crops | "I planted more things like bananas, pumpkin, corn".<br>"We plant a lot of crops which we never plant. Main thing we used to plant was cassava, not only myself but also the other people. But today, people have 1 or 2 farms just like me, and we have banana, potatoes, sugarcane and different crops we planted". |
| Helping people through farming | "Since then [Covid] I have a large farm where I could mind my children, feed my family, whoever was related to me, those who didn't had no farms, I help them in that way". |

**Preparing a farm.**

*Box 1. Contemporary Makushi farming*

Farms are always prepared for the start of the wet season beginning in May. Farmers commence farm preparation between the months of February and March. The husband is responsible for choosing the farm site; traditionally a young man may consult his elders about good sites to clear a farm if he was not that familiar with the forest. He would also gain this knowledge while hunting in the forest. He would make note of the soil, presence of water source, where the high ground was in relation to that water source and distance from home.

Today, the man may take his wife to see the site to help assess the soil quality before making the final decision to clear the area. This is a noted change from earlier accounts where the sole responsibility for deciding the location of the farm lay with the men. That view has changed in some communities with credence being given to women's experience with planting and harvesting the crops and being able to provide advice on soil productivity. With the choice made, they would together to mark the site using sticks and cloth markers. If the site is located in primary forest it will be cleared using self-help/family work. This involves cutting trees using axes, and clearing undergrowth with foices (sickle) and cutlasses. The family clears the under bush and then uses self-help to cut the larger trees. Self-help is a communal effort of getting work done quickly. At an individual level, it entails inviting other family members and friends to assist clearing or planting the farm. The host provides local (cassava-based) drinks for the participants, and sometimes food.

The newly cut farm is left for three to four weeks before it is burnt. Burning takes place downwind of the farm. This ensures a slow burn allowing more of the debris to burn. If burnt in the same direction as the wind, only the smaller debris would burn as the fire would burn faster and could escape. It is a traditional belief that as the fire burns, the man or woman can make a wish to have all their crops give fruitful productions.

After burning, the debris will be cleared, and the site will be left for the rains to soften the soil and also to beat the ash into the soil. Some families may wait four to five days before they begin planting. Depending on the condition of the soil the family will plant a variety of crops. Corn (*Zea mays*), pumpkin (*Cucurbita maxima*) and watermelon (*Citrullus vulgaris*) is planted first; corn in particular as it has a higher demand for nutrients and moisture to grow than cassava. A male farmer from Surama explains:

"*You plant corn first; when the corn meets to a certain height you plant cassava between the roots. That is how my father taught us. Corn, cassava, yams- of course yams you put in the burn heap, eddo and dasheen is also the same or you plant in the wettest part of the farm; the mud part of the farm or the lowest part of the farm. This is in some places that are low spots but when you cutting cassava farms you cut it on high land so you plant corn and cassava, banana and plantains where you burn the heaps and the vegetable farms you plant at the hill foot or swampy areas*".

To plant bananas (*Musa spp.*) and pumpkin, material is piled up at tree stumps and burnt before the sucker and seeds are planted. Other produce like sugar cane (*Saccharum*

*officinarum*), yams (*Dioscoreacea spp.*), eddo (*Colocasia esculenta*) and dasheen (*Colocasia spp.*) are planted in the swampy sections of the farm. Crops like pawpaw (*Carica papaya*), kasiri potatoes (purple potato used in the making of the local drink Kasiri) and bina plants (charms within the Makushi culture believed to assist in ones' pursuit, enhance a skill, provide protection or obtain a desired objective) are planted at the edge of the farm. Once the corn has been harvested, a variety of sweet and bitter cassava are planted. Cassava sticks are inspected for latex, and if no latex is found it should not be used as the plant will dry out and/or not produce well.

When all other crops have matured and harvested, cassava may remain as the sole crop in the field. This farm on its first planting is usually referred to as a duck farm (named after a Makushi story). During October/November, some people may begin to prepare a smaller field, called a deer bed to catch the December/January rains known as the Cashew rains, as it is the period when cashew nut trees start fruiting and nuts become available for harvest.

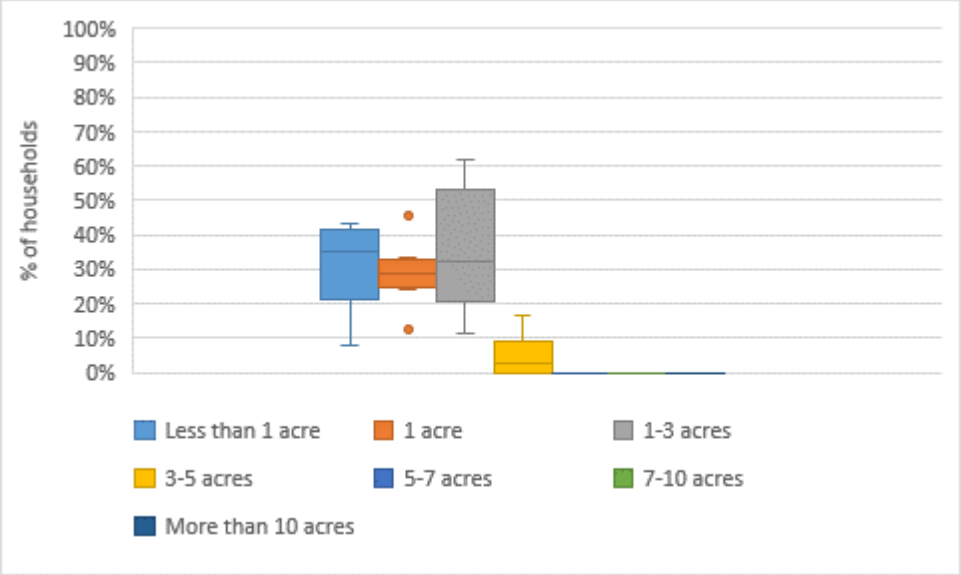
When planting is completed, the farm is maintained by the wife. She will tend the banks, preventing the seedlings from being smothered by weeds. As the cassava, grows she will cut away any branches so only the main stem remains. This will ensure that most of the plant's food resources will be directed to the root and increases its biomass. Depending on the variety of cassava used, the first crop can be harvested between four to nine months, others after a year. By traditional custom, the first harvest consists of just one warishi (traditional carrying basket weaved from the vine nibbi (*Heteropsis flexuosa*) or the cane mukoro (Marantaceae) to make the traditional drinks of parakari, arwo or kasiri (fermented drinks made from different cooking processes using cassava as the base). This is to be shared among friends and family. This harvest of cassava should not be used for any other purpose.

After the harvest, the banks may be replanted immediately. In the past, dried vegetation would be put over the beds and burned. This act would serve to re-introduce nutrients into the soil before replanting. It is a process that would also increase the length of time the farmer could potentially use the site for cultivating crops before having to move to a new location.

*Adapted from Jafferally, 2016, p171-174*

This is corroborated by the household survey data. When asked whether they cut larger farms due to the pandemic, 38% of households responded Yes and 62% responded No. The farm size data (Figure 11) shows that compared to 2012, in 2021 there were no households with less than1 acre farms, and a greater proportion of households with farms between 1 to 3 acres.

a)




b)

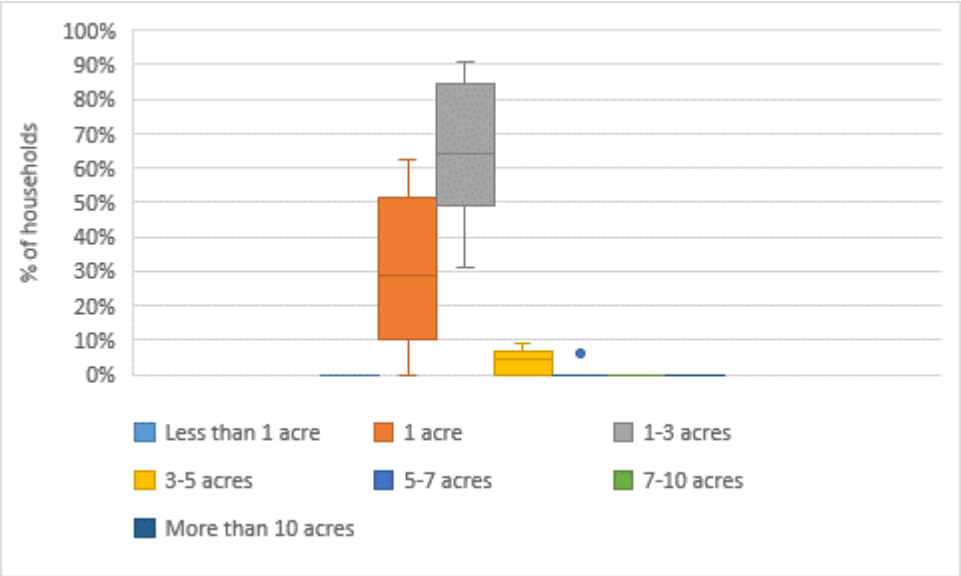
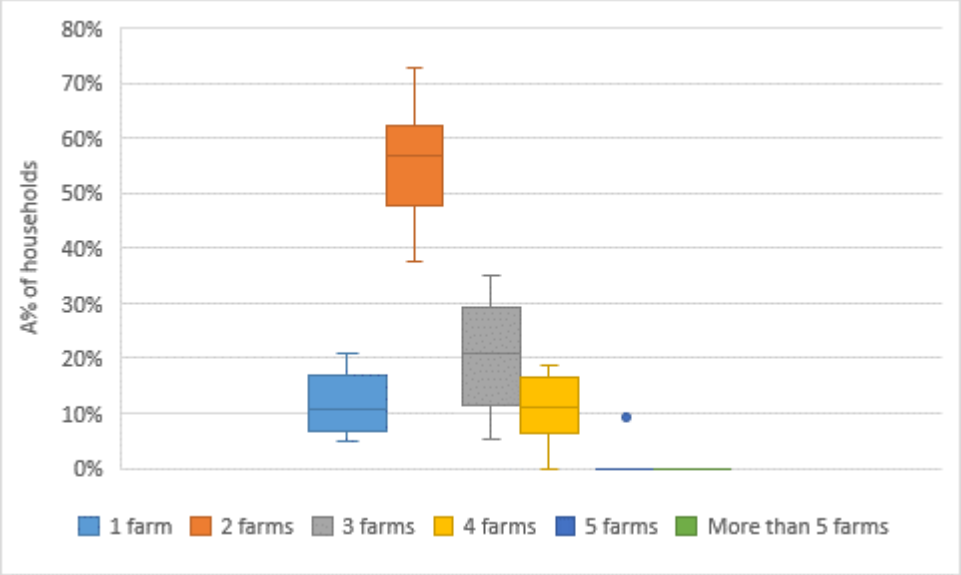



*Figure 11. Boxplots showing percentage of households with different sized farms in a) 2012 and b) 2021.*

Looking at the number of farms opened by households (Figure 12), the medianof 2 farms is higher in 2021 compared to 2012 although there is a greater spread of data. There are also more households with 4 or more farms, the outliers all being specific to Wowetta village. 65% of respondants were growing cassava in two or more farms compared to 40% in 2012.Thus, farm size seems to have increased over this 2012-2021 time-period, and more people have a greater number of farms, particularly for growing cassava.

a)

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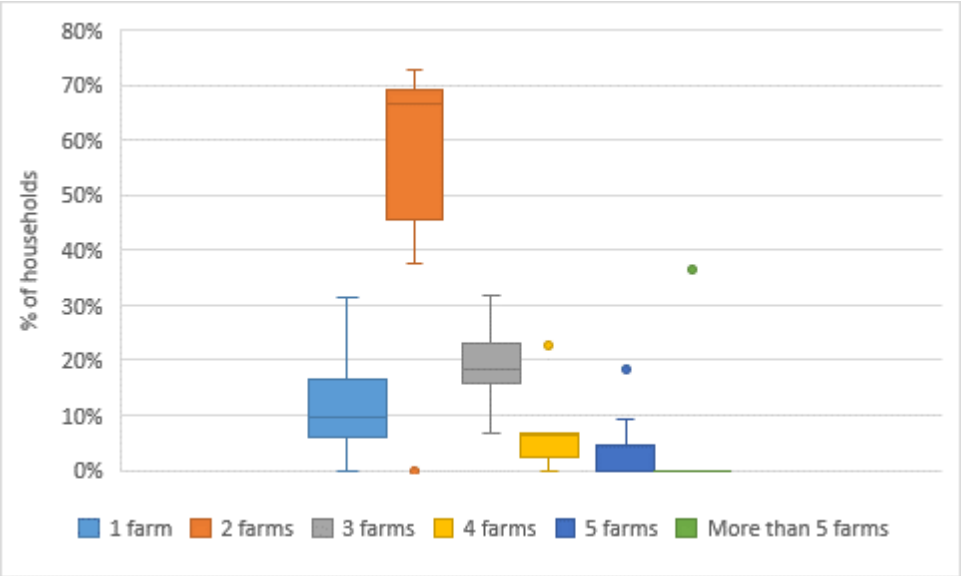



*Figure 12. Boxplots showing percentage of households with different number of farms in a) 2012 and b) 2021.*

The survey results show that 71% of households grew a greater amount of crops in 2020 compared to previous years, and 84% of households attributed this directly to the Covid-19 pandemic. The participatory videos highlight that as well as growing more cassava (the staple food crop also used to produce a number of bi-products), people also grew a greater diversity of crops, indicated by 86% of the households. These included banana, sweet cassava, plantain, potatoes, sugarcane, corn, pumpkin, sweet potato, eddo, yams, watermelons, coralia, pineapple, paw-paw, peppers, boulanger (aubergine) and okra. In

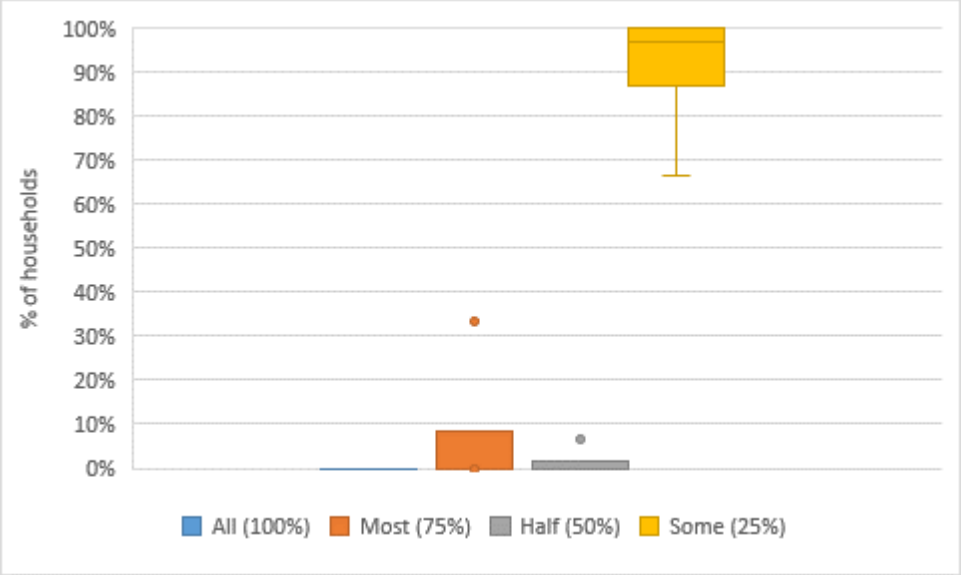
addition, 87% of households indicated that they had fruit trees, such as paw-paw, mangoes, coconut and kokerite in their farms, compared to 63% in 2012.

The proportion of people selling their farm produce was roughly similar from 2012 (68%) to 2021 (60%). However, of those selling their farm produce, a larger proportion were selling half or three-quarters of their produce in 2021 compared to in 2012 (Figure 13). This may reflect the households that cut larger farms and/or opened multiple farms to grow cassava on a larger scale for selling to other community members. In fact, 73% of the respondents confirmed that they only sold within the community.

A similar pattern is seen with cassava bi-products such as farine, cassava bread, casareep and tapioca – 82% of respondents said they sold their bi-products, with an 89% to 69% drop in the 'some' category and an increase from 2% to 17% for the 'half' and 9% to 13% for the 'most' categories. Again, the majority of these bi-products were being sold within the community. However, not all farmers were selling surplus during the pandemic; as shown in the participatory videos, people were also helping and supporting those who did not have farms or were not able to farm. This was particularly true for people who worked in sectors like education, health and the tourism, and at the beginning of the pandemic.

**Cassava bread.**

a)

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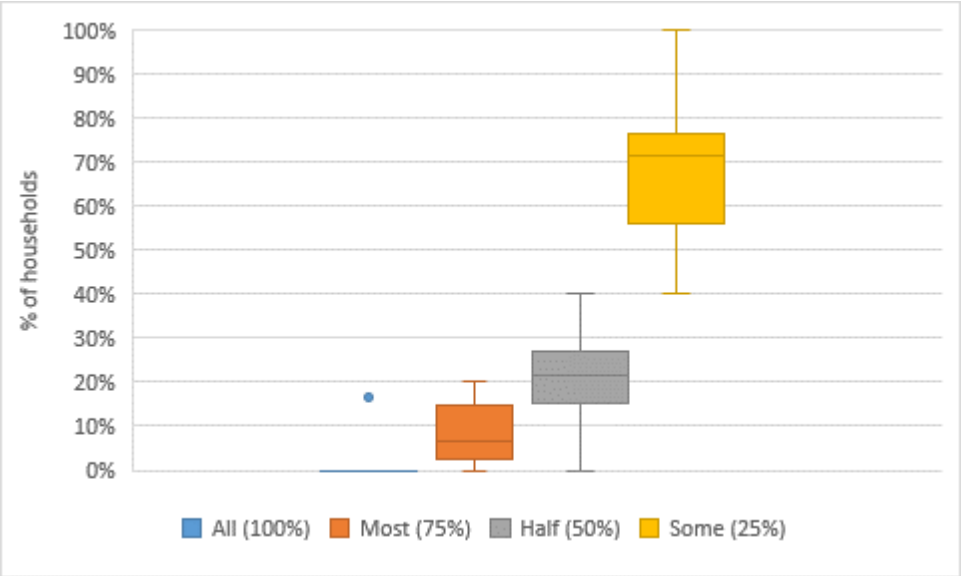
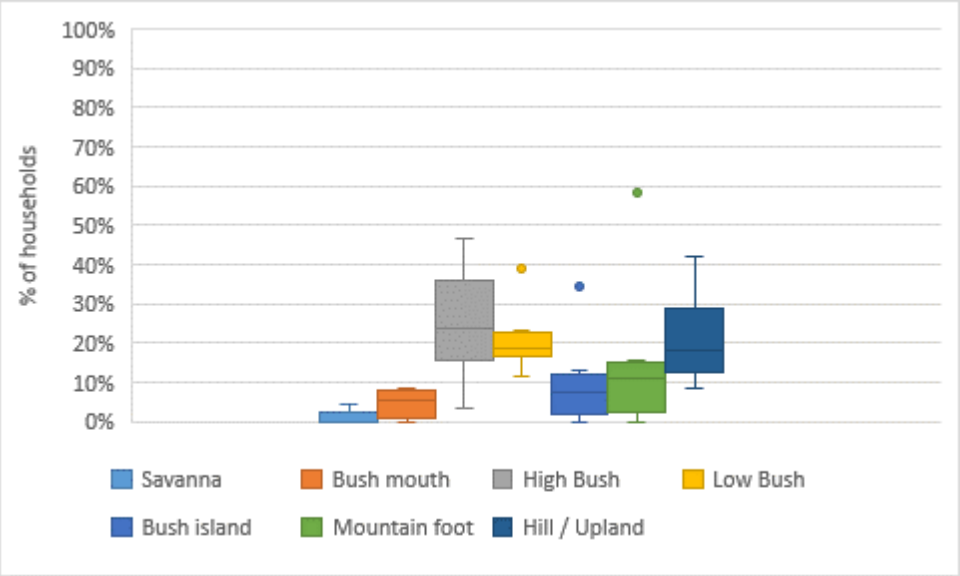



*Figure 13. Boxplots showing percentage of households selling their farm produce in a) 2018 and b) 2021.*

Other farming trends seen in the household survey data relate to the location, distance and fallow periods. For example, Figure 14 shows that compared to 2012, a higher proportion of households were farming in low bush or secondary forest in 2021. The distance to farms has decreased (Figure 15), with a greater proportion of households having farms up 5 miles away.74% of respondents stated that fallow times had become shorter (up from 68% in 2012), with 54% saying that they returned to 'minabs' or fallow farms after 1-5 years and 46% after 6-10 years (a change from 38% and 44% respectively in 2012).This highlights a trend over recent years by community members to return to their minabs as a means of

conserving ‘high bush’ or primary forest. It is believed that by doing this they are reducing carbon release when preparing their farms, a message advocated by national conservation agencies and government climate change mitigation initiatives[6]. However, what is lacking is information informing community members that as the forest gets older, the rate of carbon storage decreases, and that maintaining traditional swidden practices is more sustainable and usually carbon neutral[18]. Swidden cultivation is a valuable part of conservation landscapes, contributing to increased biological diversity and productivity[19,20].

a)

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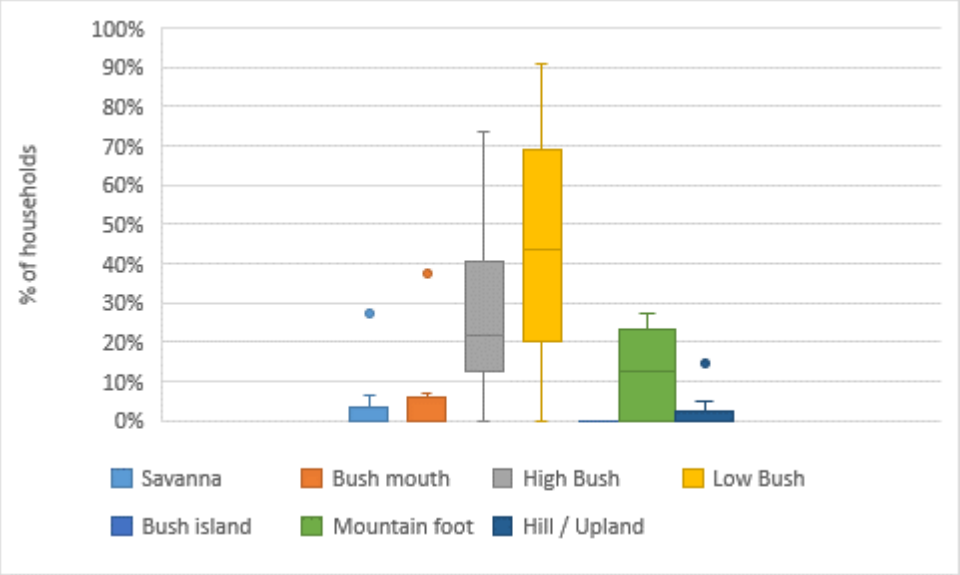
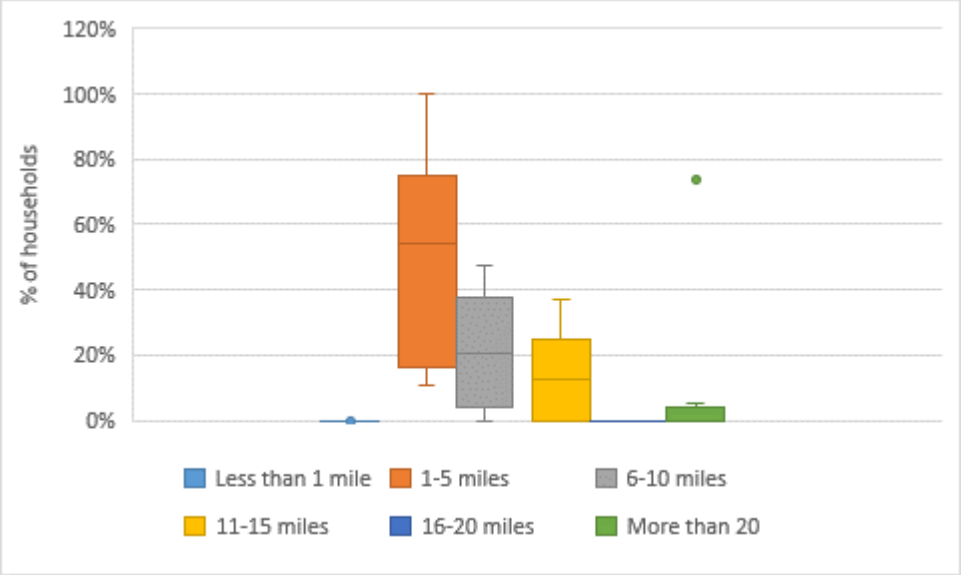



*Figure 14. Boxplots showing percentage of households farming in different ecozones in a) 2012 and b) 2021.*

a)




b)

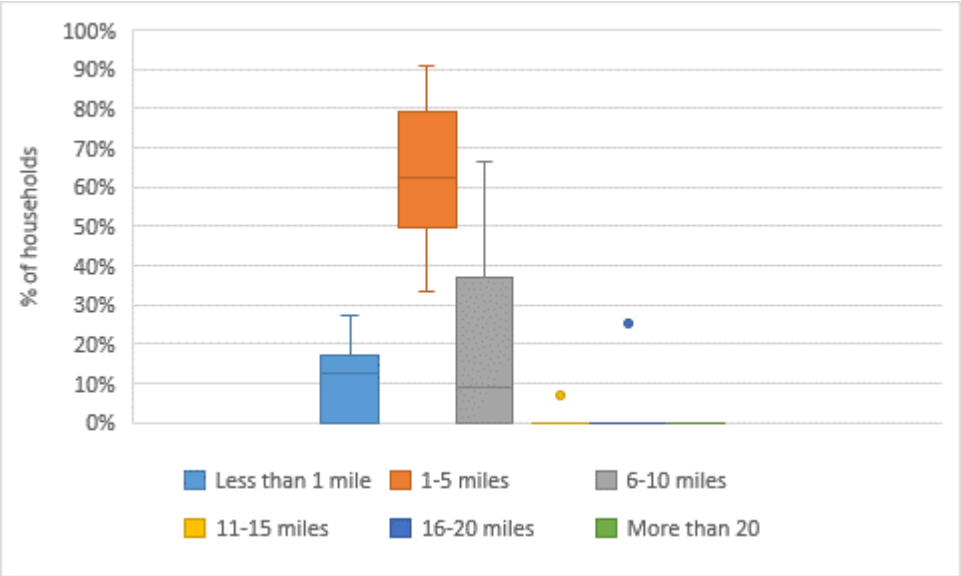



*Figure 15. Boxplots showing percentage of households with different distances to farms in a) 2012 and b) 2021.*

### 4.2.1 Trends in cassava

Cassava (Manihot esculenta) is the staple food crop for Indigenous peoples in Guyana, as well as the Amazon more widely, and forms the basis of not only nutrition, but also culture and livelihoods. It plays a central role in subsistence activities, festivities and spiritual encounters, and building social relations[21], as well as a means to earn additional cash income through bi-products such as farine and cassava bread. Agro-processing and crop production of cassava are the most important economic activities in the Rupununi region[17]. Although men are generally responsible for the initial clearance of the forest and

preparation of the farm, the propagation and cultivation of cassava, essential to the maintenance of genetic diversity, is the work of the women[22,23].

The household data indicates that the diversity of cassava grown in 2021 has significantly declined from 2012, 2017 and 1996 when a seminal study of Makushi life recorded by women Indigenous researchers was undertaken[24] (Table 3). In the latter study, 139 cultivars of bitter cassava and 8 of sweet cassava were recorded; in 2012, a total of 114 varieties of cassava were recorded; in 2017, a total of 69 varieties of cassava were recorded, and; in 2021, a total of 29 varieties of cassava were recorded. Although there are inconsistencies between the studies in the way the farmer surveys were carried out, villages sampled and total number of respondents, the data does show an overall downward trend in cassava diversity.

*Table 3. Number of varieties of cassava grown in 1996, 2012, 2017 and 2021, where nd=no data.*

| | **Number of varieties of cassava** | | | |
|---|---|---|---|---|
| **Village** | **1996[*]** | **2012[^]** | **2017[£]** | **2021[$]** |
| Annai Central | 27 | 27 | 10 | 15 |
| Apoteri | nd | 29 | nd | nd |
| Aranaputa | 48 | 22 | 11 | 5 |
| Crash Water | nd | 6 | nd | 4 |
| Fair View | nd | 16 | nd | nd |
| Kwatamang | 33 | 19 | 3 | 10 |
| Massara | 43 | 11 | nd | 9 |
| Rewa | nd | 13 | nd | nd |
| Rupertee | 41 | 7 | 18 | nd |
| Surama | 34 | 19 | 22 | nd |
| Wowetta | nd | nd | 26 | 10 |
| Yakarinta | 86 | 19 | nd | 6 |

[*]Data from Forte and Makushi Research Unit (1996)[24], based on16 months' research by Indigenous researchers in their own villages.
[^]Data from the 2012 household surveys, based on 184 respondents
[£]Data from Bulkan et al. (2017)[25], based on 120 respondents
[$]Data from the 2021 household surveys, based on 156 respondents

Looking at the specific varieties, Table 4 shows that the number of varieties grown by at least half the communities has fallen over time. The Amazon stick (a variety introduced from Brazil through the government national agricultural research and extension institute during the 1997 El Nino) has become the dominant variety. There are a number of factors contributing to loss of cassava diversity. They include the general loss of traditional knowledge as a result of colonisation, and the impact of schools and churches on the ways in which traditional knowledge is transmitted between generations and how worldviews and connections to nature are maintained[6]. A greater focus in recent times on production is

also important; for market, the variety of cassava does not matter, only the short-term production, so the more cassava grown for market, the less variation[26]. When asked why they were using the common varieties of cassava, the answer was normally "because it bear more, faster and bigger". Early maturing cassava varieties, such as the Amazon stick, can be harvested within three months and produces higher yields, allowing to commercialise part of the production while guaranteeing food security during the rainy (flood) season. Although getting more integrated in the market economy can help to purchase food or services to improve livelihoods[27,28], it may also limit farmers' capacity to cope with risk and uncertainty, and could ultimately increase their vulnerability to external shocks[29].

*Table 4. The most common cassava varieties grown in number and variety in 1996, 2012, 2017 and 2021.*

| **Number of varieties of cassava grown by at least half the communities surveyed** | | | |
|---|---|---|---|
| **1996*** | **2012^** | **2017£** | **2021$** |
| 32 | 8 | 7 | 3 |
| | | | |
| **Varieties of cassava grown by at least 90% of the communities surveyed** | | | |
| White man tree | White man tree | | |
| Large river turtle egg | | | |
| Caiman tree | Caiman tree | | |
| Parakari tree | | | |
| Saw blade tree | | | |
| | Amazon stick | Amazon stick | Amazon stick |
| | | Tepurupîye' | |

*Data from Forte and Makushi Research Unit (1996)[24], based on 16 months' research by Indigenous researchers in their own villages
^Data from the 2012 household surveys, based on 184 respondents
£Data from Bulkan et al. (2017)[25], based on 120 respondents
$Data from the 2021 household surveys, based on 156 respondents

## 4.3 Leadership responses to Covid-19

As mentioned in Section 4.1, at the start of the pandemic and lockdown, there was little information about the nature of Covid-19, and the safety measures required to limit the spread. Table 5 shows how villagers perceived the national and local leadership response. People got most of their preliminary information from the internet (where available), doctors in local clinics (where present) and the radio (Ministry of Health broadcasts where bandwidth allowed), and subsequently when government representatives came into the region, through written materials and word of mouth. Comments from Indigenous leaders during screenings pointed out how the use of 'lockdown/stay home' directives from the government during the initial onset of the pandemic did not correlate with Indigenous culture where their livelihoods require them to be out and active. As stated by an Indigenous leader during a screening "*Many of the national measures did not take into*

*consideration Indigenous peoples culture. You cannot tell an Indigenous man to stay home. When he has to fish, he has to farm, he has to hunt to get food. Not like in the city you jump in your car and head to the supermarket and come back. No! So the measures were not culturally appropriate. We develop, the SRDC* [South Rupununi District Council] *develop territorial guidelines for the entire south. If a villager wants to leave his community to go to another community, he has to get a written permit. Before he can enter the community he has to show the Toshao. So it helps us to track who is going where*".

This could explain the variability in local leaders' responses. Whereas some Toshaos and councils were pro-active, setting up community task forces and going individually to households to inform them about the virus and safety measures, in other cases, the response was slower and leaders were wary to enforce restrictions in light of peoples' subsistence needs. At the start of the pandemic, help for the communities came in the form of safety equipment, such as sanitiser, masks and hand soap, as well as food hampers, provided mainly by national organisations such as Iwokrama International Centre, Amerindian Peoples Association, Guyana Tourism Authority and the Rotary Club.

*Table 5. Main themes associated with leadership during Covid from the participatory videos.*

| **Themes** | **Illustrative quotes** |
|---|---|
| Village leaders providing information and advice | "When Covid was hot in the region….we hold a community meeting based on Covid-19, no other subject. That is where we talk about social distancing, you cannot mix around with people as before and you cannot take a trip to Annai, Lethem, Georgetown. We didn't want to lose our people, especially the pensioners". |
| Information from government | "There were flyers for our people to take note on Covid-19, how to do this, how to do that, what not to do and what to do".<br>"Government try their best to advice people, also through the radio". |
| Variability in local leaders responses | "I would say it was 50/50. We were informed but not seriously. Our leader part was not much serious about it".<br>"The leadership was not really informed. They was not trained to do anything, for them to come back and tell the villagers. They were just informed through internet and couple people they [government] sent". |
| Cash grants from government | "There was a GY$25,000 cash grant for the Covid-19".<br>"That [GY$25,000] came in handy because remember persons were laid off from work and the little grant that they give, everybody was happy and they bought rations for their household and important basic house needs". |

| | |
|---|---|
| Safety equipment came from government and organisations | "They [government] sent a lot of sanitisers, face masks and other things were coming, it was coming to the villages, coming to the council and then distributed".<br>"Iwokrama as well donated mask, as well as hand sanitiser and hand soap to the village council, as well as to the health post, and that was distributed to the villages". |
| Other food help | "They gave hampers". |
| Community helped itself | "They [council] ask few women to sew masks for the community".<br>"The village…had Task Force people, policing group, and those are the things they formed".<br>"We had information about Covid-19 that we share back with [wildlife] club members".<br>"They [community researchers] also make a video for the community and shared it out".<br>"The toshao and village council select individuals to work as a community task force...because we show interest on peoples' lives. We work by educating our community members, individuals, personally house to house...how to be aware of Covid 19".<br>"Due to Wowetta location, we are in the middle of the road and there was no where we could have really closed the road from the public, however, we did what we have to do, we installed gate, we even do patrols at night". |

In November/December 2020, as part of a national initiative, the government gave all households a GY$25,000 (~£100) cash grant, and some private individuals and the government also provided food hampers. Although most people were happy to receive these emergency funds to buy essential provisions, the effort was not consistent across all communities or all individuals within communities. For example, multiple family households only received GY$25,000, if you were a renter and the landlord was living on the site you did not get the grant, and if you were not at home you did not get the grant. This obviously resulted in disappointment, anxiety and anger amongst the communities.

In Fair View village, funds from the Village Treasury, money from their timber sales, was used to provide a cash grant to villagers: "*The village council give us GY$50,000 dollars grant from the village treasury. Who went collected the money, we went to Lethem to purchase the ration*" (male, Fairview). However, as with the hampers, this was not consistent across all community members, and led to confusion and disappointment. Later, in January 2021, the Ministry of Amerindian Affairs provided Covid19 Relief Fund grants of GY$5-10 million (~£20,000-40,000) to stimulate the local village economy. However, there was little indication or advise given on how the funds could be used, or support on the kinds of economic ventures possible, and how the village council could get products to market. It is

unclear how such funds contributed to mitigating the impacts of Covid19. For example, in some cases villages used these funds for ICT infrastructure, in others for solar panels. During the video screenings, the Ministry of Amerindian Affairs acknowledged that a better approach could have been taken "*A problem we are getting right now is the spending of the grant. Some communities already spend it out without a proper proposal. When they first received the funds, they did receive a letter with guidelines. Amount of fund given to community depended on the population size. Letter to communities is difficult still. It would have been better to have someone to explain in their language how the funds should be utilized. What might have been better is the same presidential grant approach where they have to submit a proposal first*".

The overall impression from the videos and screenings was that there needed to be far greater and more continuous support to communities by the government to provide supplies and relief during the Covid-19 pandemic. As mentioned by Indigenous leader during a screening "*I think there is a little bit of misinformation in regards to the supplies that people have. A lot of people, if you listen to it carefully and this time I did that, felt it was the Regional Government. The things that were received in the North were not from the regional government. Luckily we have our partners and they were able to get those things for us. Even the food hampers. The food hampers that we received I think was actually through the APA* [Amerindian Peoples Association]*. But all of this starts to get lost in the whole administrative thing. Looking back and looking at what is happening now in the North, we no longer have an active Covid Task Force. So why are we surprised that the cases are increasing when we have retrogressed in some ways*".

With the Georgetown to Lethem road running through the Rupununi, communities were aware of their vulnerability, particularly those situated alongside the road, and took measures into their own hands. They took their own steps to sew masks and to inform all sections of the community (e.g. to children and young adults through wildlife clubs) about the risks and safety precautions. Many communities installed gates on the main road as well as access roads, and organised patrols to limit people entering their communities, as indicated by an Indigenous leader during the screening: *"The community gates are something that was very good. Because those gates in Sourab* [Shulinab] *helped us to minimise a lot of illegal actions of Covid into the territory. The village task force is very important. That is something we had in Shulinab. The new Toshao, I asked him the other day about the task force. Every Tuesday we had our task force meeting. And listening to these videos these task force meetings were very important because it allows you now to sit review the situation, what needs to be done and you go out and do. So having that weekly task force meeting was something good*".

## 4.4 Impacts of Covid-19 on forests and biodiversity

### 4.4.1 Pre- and post-pandemic estimated deforestation in the North Rupununi region

To obtain annual forest change for our study area, we used all the radar images acquired during the dry period of each year (October-March). As outlined in Section 3.4 above, this approach avoids possible classification errors associated with flood events during the wet season. In addition, the majority of forest disturbances occur during the dry season. Annual deforestation was therefore calculated from the 1st of October to the 31stof March for the 2017-2018, 2018-2019, 2019-2020 and 2020-2021 dry seasons.

*Table 6. Estimated total area deforested for the North Rupununi region for the 2017-2018, 2018-2019, 2019-2020, and 2020-2021 dry seasons according to causes.*

| | **2017-2018** | **2018-2019** | **2019-2020** | **2020-2021** |
|---|---|---|---|---|
| **Estimated deforestation for farming (ha)** | 100 | 271 | 441 | 178 |
| **Estimated deforestation as a result of wildfires (ha)** | 620 | 977 | 1,152 | 79 |
| **Estimated deforestation as a result of road works and associated activities e.g. logging (ha)** | 4 | 13 | 109 | 20 |
| **Estimated total deforestation (ha)** | 725 | 1,261 | 1,701 | 277 |

The results obtained for the analysis of deforestation in the last 4 years in the North Rupununi region (Table 6) show a progressive increase in estimated annual deforestation rates until the 2019-2020 dry season. The 2019-2020 dry season stands out as the year with the most deforestation with an estimated area of 1,701ha. This trend seems to have been significantly curtailed in the 2020-21 dry season, achieving the lowest deforestation rate of the four years, with just 277ha. Of significant note is the major contribution of wildfires to deforestation, especially in 2019-2020. This dry season also shows a spike in deforestation associated with road works and logging activities.

### 4.4.2 Forest change near communities

To further investigate the current rates of deforestation for each of the North Rupununi communities, we spatially filtered the results focusing on two key communities associated with the highest population densities: Aranaputa and the Annai/Rupertee/Wowetta region (Figure 16, Tables 7 and 8).

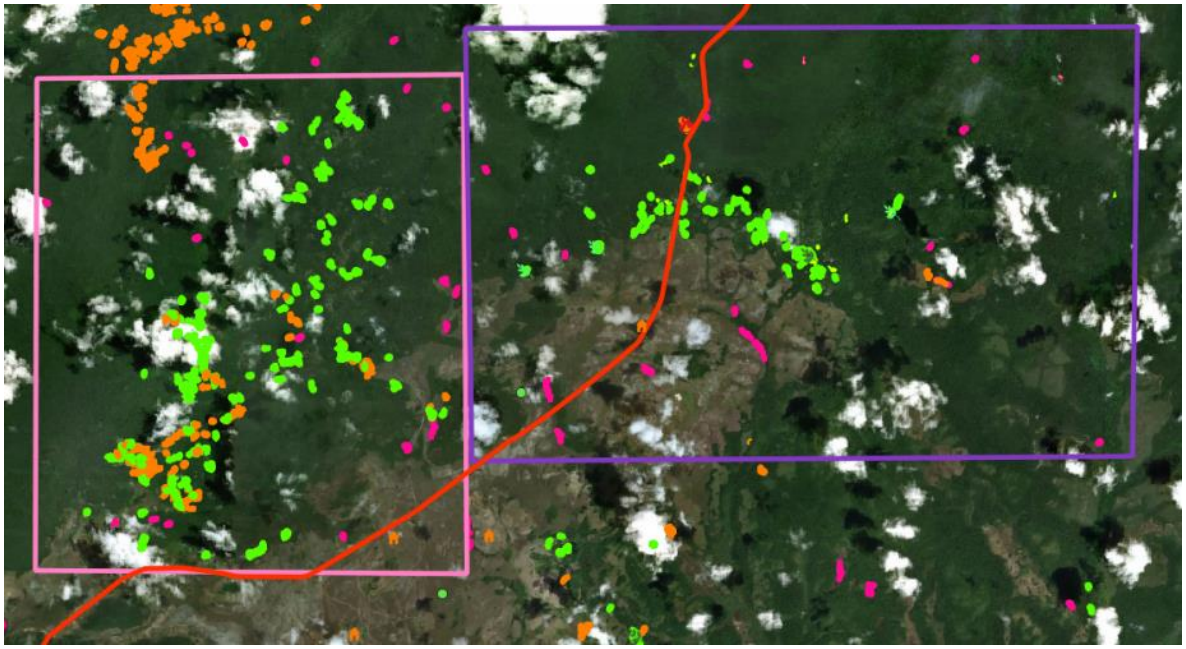


*Figure 16. Aranaputa (pink) and the Annai/Rupertee/Wowetta (purple) regions where more detailed deforestation analysis was carried out.*

*Table 7. Estimated annual area deforested for* Aranaputa*.*

| | **2017-2018** | **2018-2019** | **2019-2020** | **2020-2021** |
|---|---|---|---|---|
| **Farms (ha)** | 33 | 46 | 61 | 7 |
| **Fire (ha)** | 8 | 56 | 12 | 1 |
| **Total (ha)** | 41 | 102 | 73 | 8 |

*Table 8. Estimated annual area deforested for* the Annai/Rupertee/Wowetta region*.*

| | **2017-2018** | **2018-2019** | **2019-2020** | **2020-2021** |
|---|---|---|---|---|
| **Farm (ha)** | 5 | 12 | 38 | 24 |
| **Fire (ha)** | 2 | 2 | 1 | 1 |
| **Total (ha)** | 7 | 14 | 38 | 24 |

Results suggest that although there are similar trends to the overall deforestation rates for the whole of the North Rupununi, there are also some diverging patterns. For example, Aranaputa seems to experience a significant drop in deforestation in 2020-2021 resulting from farming and other activities, such as forestry. On the other hand, although there is also a drop in deforestation from farming and forestry in 2020-2021 in the Annai/Rupertee/Wowetta region, this is still significantly higher than the 2017-2018 and 2018-2019 dry seasons. Note also the marked differences in deforestation rates resulting from wildfires between the two regions, with the Annai/Rupertee/Wowetta region showing almost negligible levels compared to Aranaputa, where in 2018-2019, these levels actually exceed those for farming.

### 4.4.3 Potential influence of Covid-19 on deforestation rates

To evaluate the potential impact that the Covid-19 pandemic may have had on deforestation rates in the North Rupununi, we also had to consider other potential determinants, including changes in rainfall across the four dry seasons (Table 9).

The rainfall data shows that the 2017-2018 dry season was particularly dry (as the region was coming out of a severe El Nino period), especially during the core dry season period from October to March. The dry seasons then become progressively wetter, culminating in a very weak dry season in 2020-2021. This goes against the trend of increasing deforestation seen from 2017-2018 to 2019-2020. However, the very wet 2020-21 dry season could be a partial explanation for the sudden and marked drop in deforestation rates, especially with regards to the impact of wildfires, which showed a drop from an estimated 1,152 ha deforested as a result of wildfires in 2019-2020 to just 79 ha in 2020-2021.

*Table 9. Rainfall (in mm) over the 2017-2018, 2018-2019, 2019-2020, and 2020-2021 dry seasons from Lethem meteorological station.*

| **RAINFALL-LETHEM** | **2017-2018** | **2018-2019** | **2019-2020** | **2020-2021** |
|---|---|---|---|---|
| **September** | 91 | 152.4 | 180.7 | 85 |
| **October** | 28.5 | 134.2 | 55 | 53.8 |
| **November** | 8.5 | 62 | 107.1 | 154.1 |
| **December** | 53.1 | 32.7 | 20.6 | 20.9 |
| **January** | 7.5 | 7.9 | 10.5 | 81.8 |
| **February** | 2 | 0 | 1.6 | 28.7 |
| **March** | 5.6 | 0 | 1.6 | 44.8 |
| **April** | 109 | 25.2 | 19.2 | 227.5 |
| **Sep. to Apr. Total** | **305.2** | **414.4** | **396.3** | **696.6** |
| **Oct. to Mar. Total** | **105.2** | **236.8** | **196.4** | **384.1** |

Other contributory factors could be the marked investment in road building and wider economic activity peaking in 2019-2020, which was the period leading up to national

elections. Aranaputa, being one of the most commercially engaged communities of the North Rupununi, seems to have capitalised on the commercial expansion by significantly expanding its farmed area, only to have seen the greatest drop once the Covid-19/post-election economic restrictions set in. The Annai/Rupertee/Wowetta region, on the other hand, may have continued with higher levels of deforestation for farming for supporting its much higher population densities.

### 4.4.4 Google Earth Engine Web App

A new web-based interactive mapping App has been developed with the aim of enhancing community engagement and increase the impact of our research by reaching as many people, institutions, and stakeholders as possible:


https://ruizramosjavier.users.earthengine.app/view/covid-19-impacts-on-indigenous-food-sovereignity-guyana

This Open-user web application, developed in Google Earth Engine platform, provides information on the forest change analysis performed for the North Rupununi region (Figure 17).

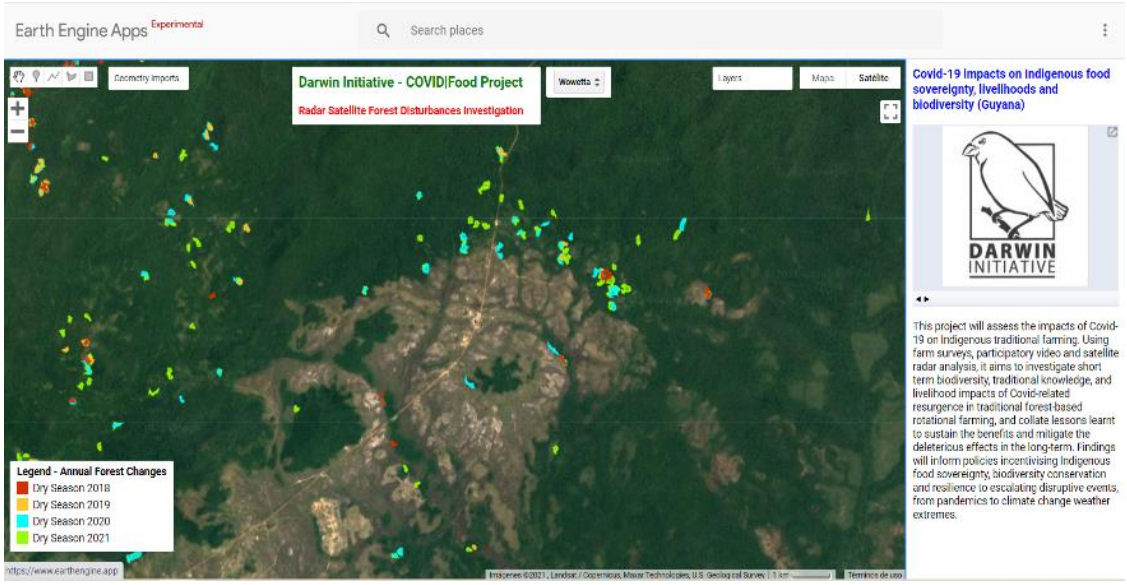



*Figure 17. Screenshot of the Darwin Initiative COVID | Food project Google Earth Engine Web App.*

The design of the web-App user interface was developed in collaboration with the communities, relying on continuous communication to acquire valuable feedback from numerous potential users when optimizing the final tool. The system has already been tested, proving that it can be accessed and run by anybody with an internet connection.

The bandwidth in the North Rupununi was sufficient to be able to handle the system but the recent internet connection upgrades have allowed a smoother and faster use of the tool.

# SECTION 5. CONCLUSIONS

Our findings show that in the short term, the Covid-19 pandemic resulted in many Indigenous community members losing paid work, including in the tourism sector. At the same time, many communities felt vulnerable staying in their villages, especially those with easy access from the main Georgetown to Lethem road, and thus retreated to their farms or backdams for safety. People turned to using their traditional medicines to both prevent, alleviate symptoms of the virus, and to strengthen their immune systems using therapies that include ginger, garlic and honey. There seems to have been a general sense of solidarity amongst community members, with people organising patrols and look-outs to protect their villages (through, for example, supporting road blocks to prevent non-community members from entering their village) and helping others with food and safety equipment. On the other hand, fear and misconceptions, possibly due to lack of awareness, also caused challenges in some communities. People who exhibited symptoms or were diagnosed but later recovered were sometimes stigmatised. This may be linked to the movement of community members from central village lands to their farms.

With more people needing to farm for survival and being located at their farms, overall there was an increased reporting of farming activity. With schools closed, whole households were able to participate in farming and/or move to the backdam. Thus it gave time for people to reconnect with different members of their families and communities, and a greater exchange of knowledge, not only about farming, but also other livelihood activities such as fishing and hunting. Some people have used the resurgence in farming to make a business, providing and selling produce, including cassava bi-products, to other community members locally.

This resurgence in traditional farming interest by community members during the pandemic is in the context of broader trends over the last 10 years. Farm sizes have increased, more households have multiple farms and fallow periods have decreased. There is an indication that a larger proportion of farms being cut are in minabs or fallow areas within secondary forest, which may have long-term consequences for the biodiversity of the forest landscape and carbon sequestration. Although a greater quantity of cassava and diversity of other crops were planted during the pandemic, there has also been a significant drop over time in the varieties of cassava used by farmers, with a current reliance on a handful of landraces.

The remote sensing shows that the increase in farming interest and activity by communities does not translate into a significantly greater area of forest being opened during the Covid pandemic. In fact, the remote sensing analysis indicates that compared to previous years, the 2020-2021 pandemic year had less deforestation from farming (and fires). Although people cut new farms during the pandemic, many also may have intensified farming activity on already established farms. The levels of deforestation are a complex mix of farming, fires, climate (wetter/drier years) and governance (political factors driving economic and infrastructure developments), and require further detailed investigation. For example, the exponential rise in deforestation rates from 2017 to 2020 may have been fuelled by

significant development investment by the incumbent governing political party as national elections neared (these eventually took place on the 2nd of March 2020). The remote sensing analysis shows that there was an explosive grow in deforestation as a result of roadworks. Improvements in transportation access for commercial activities may have, in turn, incentivised more farming and other commercial activities, such as logging, commercial fishing, and cattle ranching. Greater farming, ranching and extractive activities, may, in turn, have resulted in more wildfires being set, as people needed to facilitate access to the landscape.

The break-down in commercial activities, as a result of post-election disinvestment and the later onset of Covid-related travel restrictions, combined with the significant increase in rainfall result from the La Nina phenomenon, may explain the sudden and drastic drop in overall deforestation rates from the extreme peak of 2019-2020 to the drastically reduced figures for 2020-2021. However, this 'big-picture' hypothesis may mask the more granular and nuanced results emerging from the community-based surveys, which indicate a resurgence in interest for traditional farming practices.

So, overall, there may have been a drop in deforestation rates emerging from commercial farming activities, but the community interviews suggest that subsistence farming may have actually increased. This complex development can be seen in the distinction between the Aranaputa and Annai/Rupertee/Wowetta region deforestation trends, where the greater focus on commercial agriculture in Aranaputa actually saw a major crash in deforestation rates during 2020-2021, compared to a much more modest fall in Annai/Rupertee/Wowetta region, which has a less developed commercial sector.

So what lessons can be learnt to sustain the positive consequences of the pandemic and mitigate the negatives impacts in the long-term?

The headline results indicate that prior to 2020-2021, the North Rupununi was in a dangerous trajectory of increased deforestation rates. The drier weather, combined with significant development incentives, had resulted in deforestation peaking at an estimated 1,701 hectares for the 2019-2020 dry season, which roughly equates to almost 0.5 million tons of $CO_2$ being emitted into the atmosphere. The radical change in political, climatic and pandemic-related circumstances of the 2020-2021 dry season resulted in a drastic drop in deforestation rates to an estimated 277 ha – just 16% of the levels seen in the previous dry season. But how can the radical turn-around in deforestation rates, combined with the resurgence in interest in traditional farming, be sustained if and when the North Rupununi reverts back to 'business as usual' conditions? This project has identified some key recommendations.

Firstly, Indigenous communities and leaders pointed to the need for more culturally appropriate information. They advocated for a programme, perhaps from the Ministry of Amerindian Affairs and including the National Toshaos Council (NTC) that would align with Indigenous livelihoods and worldviews, on how responses to a pandemic should be framed. This would ask questions such as what is it that communities really want under these

circumstances, what and how should information be shared, and how can/do communities themselves develop their own actions, with their own knowledge, to deal with crises.

Cassava diversity needs to be promoted. As well as contributing to Indigenous identity, health and richness of culture, different varieties of cassava are adapted to different soil types, typography, climatic conditions (droughts, floods) and pests. Agrodiversity can help mitigate the impacts of climate change and other crises in the future, and urgent work needs to be done to enable cassava diversity to be protected and enhanced.

Greater technical advice and support is required, especially when it comes to promoting and diversifying food systems. This includes knowing the correct agencies and individuals to contact, and small amounts of funding to initiate enterprises. Even when funds are provided, there needs to be capacity building to ensure that communities have the skills and means to market produce and be more food secure. In the screenings with the Ministry of Agriculture, on-going crop extension activities including capacity building and supply of inputs, as well as supporting farmers with marketing their produce, was mentioned in response to the participatory videos. This needs to be taken forward in ways that build on traditional knowledge, Indigenous culture and cassava diversity, and work though ministry and community structures such as the Community Development Officers and Community Support Officers under the Ministry of Amerindian Affairs and the crop extension officers under the Ministry of Agriculture respectively.

Finally, land tenure is critical for food sovereignty and biodiversity, and preventing the forests that Indigenous communities have sustainably maintained for centuries from being destroyed and degraded as a result of external commercial pressures. Having legal tenure helps to secure resources and land needed to cope with pandemics, in which sustainable land management and practices can be governed and self-determination can be promoted. Without this safeguard, the North Rupununi communities risk a bleak future where their precious forests have either being destroyed or degraded.

**Cassava processing.**

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# APPENDIX 1 - Household farming survey

Date of interview

Name of CREW entering data

Community name

Name of interviewee

Age

Gender

Size of household

Have you farmed?

If no, did you have a farm in the past 5 years?

If no, where did you get what you needed from?

Do you have a job to support yourself?

Has your job supported you during the Covid_19 pandemic?

Did you farm before Covid-19 pandemic?

How long have you being farming? (years)

What type of farming do you do?

Do you have more than one traditional farms?

How many plots have you farmed?

What is the size of your farm? (acres)

Have you cut larger farm because of Covid 19- pandemic?

If yes, how many?

Number of other immediate persons depending on your farm/s?

Who are the people that benefit?

Where are your farms located?

What is the vegetation type of your farm?

Are you farming now on primary or secondary forest?

What is the shape of your farm/s?

Why did you choose this area?

Is this location different from before?

If yes, where did you farmed last?

How long have you being using these farming grounds? (years)

Do you know if anyone had farmed this area before you?

If yes, do you remember who farmed it?

Do you remember when it was farmed?

What method/tools do you use for clearing of your farm land?

What type of soil is your farm located on?

Do you still have any old farming ground that you still harvest from?

If yes, how old is the farming ground? (years)

What crops do you still harvest from these farming grounds?

Do you sell any of your traditional farm produce?

How much of your traditional farm produce do you sell?

What three top produce do you sell the most?

Where are the produce being sold?

Do you sell any of your traditional farm bi-products?

What are the bi-products you sell?

How much of your traditional bi-products do you sell?

Where are the bi-products being sold?

How far way is your farm from your home (miles)?

What mode of transportation do you use?

How often do you visit your farm/s?

How long does it take you to get to your farms? (hrs)

How do you fetch your load/ farm produce to and from your farm?

Do you have a house, camp, or other dwelling on the farm?

Did you stay in the farm during the Covid-19 pandemic?

For how long(days)?

How long on average do you stay when you go to each of your farms?

What cassava bi-products do you process at your farms?

If other, please specify

How important is cassava/ cassava bi-products for your survival and livelihood?

Please explain why cassava bi-products are important to you?

What do you make these cassava bi-products for?

If for sale, where is the market?

Do you process or sell cassava/cassava bi-products on a commercial scale?

If for sale, where is the market?

Did you plant more or less / same crops before 2020?

Did you increase the amount of crops you planted because of Covid-19?

Did you plant more varieties of crop because of Covid-19?

Are there any fruits trees on your farms?

If no, where do you get your fruits from?

Do you plant other crops in between other crops?

If yes, which crop do you plant this way?

Do you plant crops separately?

If yes, which crop do you plant in this way?

Do you plant corn in between other crops?

If yes, why?

Do you have any other method that you use to plant your farm?

Do you have cassava on your farm?

How many farm do you have cassava planted on right now?

How do you plant your cassava?

Name the different type/varieties of cassava you have planted on your farms

Why did you decided to plant these crops?

Do you have any other type of cassava stick that you did not had before 2020?

If yes, please name them

How did you get those sticks?

How do the different type of cassava varieties you have on your farm stand up to the weather? Drought

How do the different type of cassava varieties you have on your farm stand up to the weather?  Flood?

How long do you leave an old farming area before going back to cut it?

is the time period that you leave an area to go back shorter or longer than before?

What kind of bush or vegetation are you use to cut new farms?

What is the length of time you farm in virgin forest?

What is the length of time you farm in minab forest?

What factors affect the time period that you can farm, cultivate your crops in virgin forest? ( years)

What factors affect the time period that you can farm, cultivate your crops in minab forest? (years)

If you have a farm in the savanna, is this for permanent use or short time use?

Was your farm ever destroyed by fire?

If yes, when?

How large an area was destroyed by fire?

What was damage and what did you lose?

Do you know what cause the fire?

What method do you use to reduce the risk of fire on your farms?

What are the threats to your farm/s?

What is the biggest threat to your farm/s?

What pest and diseases affect your farm/s?

What inputs do you rely on to increase your farm yield/output?

Do you have a fence farm in the forest?

Do you have a fence farm in the savanna?

What kind of materials do you use to fence in the forest?

What kind of materials do you use to fence in the savanna?

Why do you fence your farms in the forest?

Why do you fence your farms in the savanna?

# APPENDIX 2 – Participatory video interview checklist

**General Information**

1) Background information: name, age, village

2) How long have you lived in the village?

**Farming and Covid-19**

1. Do you do farming?
2. How has COVID-19 affected your farming?
    a. do you have more or fewer farms? How many compared to before COVID-19?
    b. have you opened up new areas for farming? If so, where? How big are they roughly? Are these farms bigger or smaller than before COVID-19 or the same?
    c. what did you plant in your farms? Was it different to before? Was there more or less of anything?
    d. how many people were you feeding during COVID-19? Did this change from before? If so, why?
    e. who helped you in the farm(s)? Were they the same people as before? Did youth and children participate? Was this different from before, and if so, how?
    f. how long did you stay on your farm(s)? Is this different from before COVID-19? Tell us what kinds of activities, apart from farming, you did while you stayed on your farm(s).
3. did you have the knowledge to farm? Did you plant anything new that you needed the knowledge for?
4. What about farming do you think COVID 19 made better or worse?

**Covid-19 and community life**

1. How has your life been affected by COVID-19?
2. Do you work or did you work before COVID 19? What do/did you do? Has there been any changes with your work?
3. If you lost work, how did you make money to support your family during COVID 19?
4. Did you sell any produce from your farm?
5. What other activities did you do to support your family? (hunt, fish, timber, gathering, mining)
6. Would you say you've done more, less or the same amount of these activities during COVID-19, and why?

7. Did other people come to the area to get resources? (fish, hunt, timber, gather, mining)
8. Was it more than normal? Did more people come through the area to get resources?
9. Do you think more persons depended on their traditional knowledge to survive COVID-19?
    a) Which areas was traditional knowledge more important? (e.g. traditional medicines, farming, policing river, roads and territory)
    b) Did anyone stand out who was using traditional knowledge to help during COVID 19?
    c) Do you think people took the time to share their knowledge with others? (family, friends)
10. How has COVID 19 changed your way of life??
11. How do you feel about the changes you had to make?

**Leadership during Covid-19**

1. How well were people informed about COVID 19?
2. How quickly was action taken to inform communities about COVID 19 and measures put in place?
3. How well did you think local leaders - toshaos and councillors - responded to COVID-19?
    a. What measures were put in place?
    b. How did people respond?
    c. Were these measures enough?
    d. What other actions could have been taken?
4. What about regional and national leaders how well did they responded to COVID-19? Did they visit to provide information/answers?
    a. What measures were put in place?
    b. How did people respond?
    c. Were these measures enough?
    d. What other actions could have been taken?
5. What kind of measures should leaders, national and local, put in place for future should something similar happen again?
6. Overall, what would you say have been the positive and negative impacts of the COVID-19 pandemic?