

## Influence of Livelihood Assets' on Farmers Control Practice for Enset

### Xanthomonas Wilt in Southern Ethiopia

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### Henok Tesfaye

College of Agriculture and Natural Resource, Wolkite University, Wolkite, Ethiopia

Email: [heniabm@gmail.com](mailto:heniabm@gmail.com)

Telephone: +251924498967

ORCID Number; 0000-0002-4763-7194

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### Abstract

*This study examined how the livelihood assets influence enset farmers' decisions to control the disease Xanthomonas Wilt. For examining how household adopt their farming practices to control the disease and preserve their livelihoods, useful theoretical architecture represented by Sustainable Rural Livelihood (SRL) framework were used. Empirically, double-hurdle model was applied. The results indicated that the human, social, natural, physical capitals and vulnerability context are the driving factors for adopting the recommended EXW controlling strategies. Natural capital negatively associated with extent of adoption decision of the farmer whereas the social capital influences it positively. This finding promotes the importance of improvement of livelihood assets to enable significant support to the natural and social capitals of the farmer that provide important resources and information exchange for continuous adoption of EXW controlling strategies.*

**Keywords:** Enset; southern Ethiopia; sustainable livelihoods framework; Xanthomonas Wilt.

### Introduction

Enset based farming system is among an indigenous and sustainable agricultural system that covers large hectares of land in Ethiopia (Belachew, G., Aklilu, A., Bewuketu, H., & Habtamu, K. 2017). Enset production provides the staple food for around 20 million Ethiopians (Borrell, J. S., Biswas, M. K., Goodwin, M., Blomme, G., Schwarzacher, T., Heslop-Harrison, J., Wendawek, A. M., Berhanu, A., Kallow, S., Janssens, S., Molla, E. L., Davis, A. P., Woldeyes, F., Willis, K., Demissew, S., & Wilkin, P. 2019). Moreover, it has multiuse and all part had usage for different purpose. The major products obtained from enset are human food (*Bulla, Kocho and Amecho*), fiber, animal forage, construction material and medicines (Melaku, 2021).

However, *enset* production in Ethiopia has been harshly threatened by enset bacterial wilt (EBW) (Ambachew, Z., Gezahegn, B., Sintayehu, L., & Kefelegn, G. 2019; Adane 2018). It is a vascular disease that results in yellowing and wilting of leaves, and finally collapses the entire plants. It is the most upsetting since it kills enset at all growth stages and landraces. Research shows the disease can cause losses of 70 – 100% in enset

production. Therefore, area coverage and production of enset is declining over time and many farmers are substituting enset production with other crops (Kusse, K., Ermias, G., & Darch, D, 2021; Ambachew, Z., Gezahegn, B., Sintayehu, L., & Kefelegn, G. 2019). The situation resulted in food scarcity in southern Ethiopia in particular and in enset based farming area of Ethiopia in general.

The government of Ethiopia devoted a lot of efforts to controlling EXW over the last 10 years. However, there are no chemical management methods for this disease so management is based on cultural control methods (Belachew, G., Aklilu, A., Bewuketu, H., & Habtamu, K. 2017; Yemataw, Z., Mekonen, A., Chala, A., Tesfaye, K., Mekonnen, K., Studholme, D & Sharma, K. 2017). EXW Management package identified and practiced in the country include; dis-infecting processing and farming tools, keeping fields and surrounding area free of weeds and volunteer plants (alternative hosts), uprooting and burning the infected enset plants, exposing the soil to sun prior to planting, proper spacing, avoiding overflow of water from infected to uninfected fields, controlling porcupine, mole rat, and domestic animal from browsing, replant using clean planting tools, controlling movement of planting material and crop rotation (Kusse, K., Ermias, G., & Darch, D. 2021; Adane, 2018).

Proper use of cultural practice and sanitary control measure were suggested to minimize pathogen spread in general and enset *Xanthomonas Wilt* in particular (Yemataw, Z., et al., 2017). However, to keep the incidence of the disease at manageable levels sustainable adoption of recommended cultural practice is crucial. Although, dealing with factors influencing farmers' adoption behaviors is significant to effectively control EXW. Moreover, farming household strategies depend on condition of their livelihood asset (Pagnani, et al., 2021).

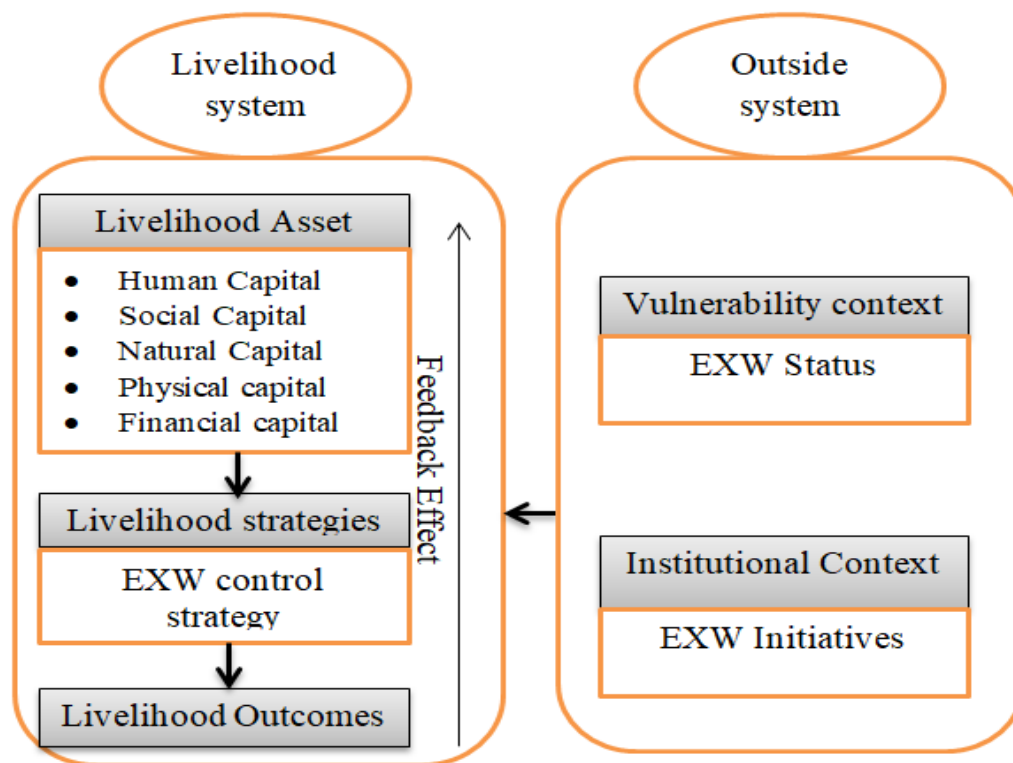
Accordingly, this study investigated the relationship between farmers' livelihood assets as well as the outside system and their adaptation practice to control EXW. The Sustainable Rural Livelihood (SRL) framework was employed with focus on the livelihood systems of rural households and how they adapt their farming strategies to address external forces, while preserving their livelihoods. Double-hurdle model was applied, to identify factors that influence farmers' decision to adopt and its intensity. This study result could offer broader information on decision-making processes of farmers' and insights for more effective intervention for ensuring an adequate level of EXW mitigation strategies.

## **The Sustainable Rural Livelihood Framework**

The theoretical design of this study is the Sustainable Rural Livelihood (SRL) framework (Figure 1). Rural households' livelihood systems are the centers of this framework which have interaction with the outside system. Livelihood systems of the farmers having the purpose of improving livelihood outcomes are based on assets as well as the strategies employed. The outside system is composed of the vulnerability and the institutional context. The livelihood system will be altered by the changes in the outside system.

The framework highlights the rural households' strategies, which are decisions internal to the household with the aim of improving their livelihoods, while households may adapt their strategies in response to external tremors by using the four integrated cultural

practice packages (i.e. dis-infecting tools, removing infected plants, dis-budding and using clean planting material).



**Figure 1: The sustainable rural livelihood framework**

Source: Adapted from Pagnani *et al* (2021).

## Methodology

The study was conducted in southern nations, nationalities and peoples region (SNNPR) of Ethiopia which is located at Latitude: 6° 03' 31.03" and Longitude: 36° 43' 38.28" E.

The survey was conducted between September and May 2021. The data were collected through individual interviews using a pre-tested questionnaire. Three stage-sampling techniques were applied to select the representative sample households. First, three major Enset-growing zones were selected purposively based on their prevalence incidence of enset bacterial wilt. Second, three districts were selected randomly from each zones, the selected nine districts were as follows: Cheha, Enemor, and Ezha from Gurage zone; Lemo, Dunna and Misha, from Hadya Zone; and Boloso Sore, Damot Gale and Damot Pulasa from Woliyta. Finally from the lists (98000 HH) provided by the agriculture and rural development office of the respective districts, 540 households were randomly selected based on probability proportional to the population size of the selected districts.

In order to examine how the five capitals, vulnerability and institutional context influence the decision as well as the intensity of adoption of the EXW controlling strategies, double-hurdle model was used. The first hurdle was used to determine whether the individual

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adopt or not and the second hurdle was used to determine the intensity of adoption if the individual adopt. For the purposes of this analysis, the dependent variable is the number of cultural practice adapted by the households.

## Empirical model variables

The livelihood assets, livelihood strategies, and the outside contexts were emphatically contextualized. Therefore, the following variables were identified and used in this study.

### Livelihood strategy

It is the combination of activities that household would implement to achieve their livelihood goals. Therefore, to limit the spread of the EXW, the strategy adopted by the enset farmers is based on the following four cultural EXW controlling practices: (1) disinfecting tools (2) removing infected plants (3) dis-budding and (4) using clean planting materials. Therefore, as per the number of practices adopted by the household the value of dependent variable will be 0 up to 4. Zero value stands for non-adopters, while value 4 refers to full (adopters).

### Livelihood assets

It is the resource base of different households and is often classified as human, social, physical, financial and natural capital. Applying specific strategies by the household may be justified by different endowment of the assets (García, de., Jalón, S., Iglesias, A., and Neumann, MB. 2018). Through considering different literatures, the researcher chose a set of indicators to measure those capitals.

In this study human capital was measured with (1) age, (2) number of household members and (3) level of education of the HH head. Either negative or Positive effect of age on the adoption is expected based on the previous different findings (Chete, 2021; Feyisa, 2020). The main reason behind this could be the more younger/older the farmers are, the less likely the farmers are adopters due to lack of information about the variety. However, it has a positive effect on the adoption of technology when the household head is within the productive age (Feyisa, 2020). The family size impacts the adoption process positively because a larger family member in household has greater labor capacity required for introduction of a new practice (Fikadu, 2020). Lastly, educational level influences the farmers' attitudes and thinking, which in turn enable them to access and utilize information about the problems they face (Kaliba, A.R., Mazvimavi, K., Gregory, T.L., Mgonja, F.M. and Mgonja, M. 2018).

Social capital is represented by these three variables (1) gender of household head (2) access to extension service and (3) cooperative membership. Male has better opportunities to move outside his home and for participating in different extension programs than females and hence he can get better information/knowledge to adopt technologies. Additionally, male has better access to resources than female. Study conveyed by Zhang, S., Sun, Z., Ma, W., & Valentinov, V. (2020) presented the positive impact of being a cooperative member on adoption of technologies. Therefore, this study expects the positive influence of sex, access to extension services and cooperative membership on the introduction of new technology.

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The study used: (1) the farm's location, (2) the total farm area, and (3) land allocated to enset production to measure natural capital. Regional difference was the major factor that influenced the adoption decisions of the household (Kikulwe EM, Kyanjo JL, Kato E, Ssali RT, Erima R, Mpiira S, Ocimati W, Tinzaara W, Kubiriba J, Gotor E, Stoian D, Karamura E. 2019). Since farm size is considered as indicator of wealth status, the farmers having larger farm have means and capacity to take adaptive measures. The land allocated to enset would take as a proxy for the importance of enset production (Mulatu, 2021). When the farmers give high position to enset production they will give much emphasis to take adoption options to control EXW disease.

The type and size of house and farm equipment used by the household were considered to measure the physical capital, because they are able to enhance household well-being, as well as the likelihood of adoption (Shinbrot. X.A., Jones. K.W., Rivera-Castañeda. A., López-Báez W., Ojima. D.S. 2019).

Finally, for representing financial capitals, enset farming objective (commercial and subsistent), access to credit facility and off-farm income source were measured. Financial capitals can overcome cash deficit of many households especially in developing country (Shinbrot. X.A., Jones. K.W., Rivera-Castañeda. A., López-Báez W., Ojima. D.S. 2019; Feyisa, 2020). Accordingly, a positive relation is expected between financial capital and adoption of the EXW control strategy.

## Outside context

Vulnerability context and the institutional context are two sets of external forces were considered in this study. They could influence households' livelihood outcome. A variable EXW communication approaches was considered as a proxy for institutional context for this study. It is measured as "1" if the household has participated in training and field study or zero if not.

To represent the Vulnerability context, the study used EXW status of households' farms as a proxy. The variable has value from 0 to 5; based up on length of time that EXW was last observed on the farm. Zero indicates it has been a year since EXW was last observed (i.e. low disease status), while 5 indicates the EXW still exist on the farm (vulnerable).

## Results and Discussion

### Adoption level of the Recommended Cultural Practice

Out of the four cultural practices the most frequently employed practice was removal of infected plants (see Table 1), since 54% of the sampled household adopt this practice, followed by timely removal of male buds or infected parts which is practiced by 45% of households, while 41% of the sampled households used disinfecting tools like fire and/or cattle urine.

Households which apply only one cultural practice out of the integrated package, the widely practiced were dis-budding (56%). Households that implemented above one practices the frequently adopted practice were the dis-infecting tools and removal of

infected plants. Using clean planting material during replantation was the least adopted practice with just 10% only.

Concerning the complimentary adoption of the four integrated cultural practices, 21% of the sample sizes were non-adopters, while only 0.37 % of the sampled smallholders fully adopt the EXW control strategy. The remaining 78.63% of the sample households are Partial adopters. This indicates most of the sampled households adopt at least one of the recommended EXW cultural practices.

**Table 1: Level of adoption of recommended cultural practice to control EXW**

<b>BXW controlling Practices</b>	Sample Mean(SD)	Non Adopters Mean(SD)	1 practice Mean(SD)	2 Practices Mean(SD)	3 practices Mean(SD)	Fill-adopters 4 practices Mean(SD)	F test <sup>1</sup>
Disinfecting tools	0.41 (0.49)	0.00 (0.00)	0.01 (0.11)	0.72 (0.49)	1.00 (0.00)	1.00 (0.00)	682.41***
Remove infected plant	0.54 (0.49)	0.00 (0.00)	0.33 (0.49)	0.81 (0.24)	1.00 (0.07)	1.00 (0.00)	453.99***
Dis-budding	0.45 (0.50)	0.00 (0.00)	0.56 (0.50)	0.35 (0.50)	0.99 (0.09)	1.00 (0.00)	206.26***
Clean planting material	0.10 (0.10)	0.00 (0.00)	0.10 (0.08)	0.10 (0.10)	0.10 (0.11)	1.00 (0.00)	66.20***

### Factors Influencing Farmers Control Practice for Enset *Xanthomonas* Wilt.

The double-hurdle model result indicates farming household decision about adoption of EXW cultural management practice are related with human, natural and social capitals and vulnerability context. However, social and natural capitals influence the intensity of adoption influence (Table 2).

The first hurdle result indicates that out of the human capital variable, age is the only variable that increases the odd of non-adoption. This might be due the fact that as the farmers get older; there is a weakening of investment on the farm and higher risk aversion. Moreover, young farmers generally are fast to try new technology (Feyisa. 2020).

In case of physical capital, farm equipment index negatively and significantly related with non-adoption. This result consistent with Shinbrot. X.A., Jones. K.W., Rivera-Castañeda. A., López-Báez W., Ojima. D.S. (2019), they found that farmers adapt to climate events because of their farm equipment, vulnerability and group membership. A possible explanation would be the adaptation options are done with some sorts of existing farm equipment.

The only livelihood assets that Cause significant variation in the two adoption decision process are the social and natural capitals. From social capital related variables, interaction with extension services counteracts the likelihood of non-adoption of the EXW. This is because the frequency of contact between farmers and extension personnel makes current and updated information available and accessible to farmers. Instead,

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Male-headed households are more likely to adopt more practices against EXW as compared to female-headed households. This finding is in line with earlier study that shows gender (male) had positive influence on adoption of improved agricultural technologies (Kikulwe EM, Kyanjo JL, Kato E, Ssali RT, Erima R, Mpiira S, Ocimati W, Tinzaara W, Kubiriba J, Gotor E, Stoian D, Karamura E. 2019). However, most activities of enset production are controlled and managed by women, who have less access to extension service and resource (Mulatu, 2021).

The regional difference is among natural capitals that significantly influence both decision and intensity of adoption of the controlling practices. As compared to farming household in Woliyta zone, farming households in Gurage and Hadiya are more likely to adopt only one practice. These findings support recent study that highlights the relevance of regional differences (Pagnani, et al., 2021). A reasonable explanation would be enset production play unbeatable role for both commercial as well as consumption purposes in Woliyta Zone. Consequently, there has been a great involvement of different stakeholders in the sector.

The first hurdle result also indicates that as land allocated for enset production increase, it is less likely the farmer is not to adopt at least one of the EXW control practices. This result is in line with previous study that land holding is a key factor that affect farmers adoption of climate related adaptation strategy (Shinbrot. X.A., Jones. K.W., Rivera-Castañeda. A., López-Báez W., Ojima. D.S. 2019). The result of the second hurdle also indicates that this variable increase the intensity of adoption of EXW controlling strategy. The notion that farmers want to eliminate the disease from their farm is based on the importance they attribute to enset as a food or income crop.

Financial capital does not have any influence on both the decision and the intensity of adoption of the identified strategies in this study. The result of this study might be due to the fact that the identified disease controlling strategy does not need additional finance since there is no controlling mechanism that needs additional finance.

The vulnerability context decreases the likelihood of non-adoption of the EXW controlling strategy. The result implies that farmers have awareness about this strategy; however, they will adopt it when the shock comes. This finding corroborate the previous finding that rural households will not take it as general practices rather only modify and apply when the disease affect their production (Pagnani, et al., 2021). This would make the problem too difficult to control if there is strong disease resurgence.

**Table 2: Factors influencing farmers control practices for EXW**

Variables	Coef.	SE	Coef.	SE
<b>Human capital</b>				
Age of HH head	0.017*	0.008	0.000	0.001
educational level of HH head	- 0.126	0.098	- 0.019	0.008
Member of HH	- 0.053	0.050	0.007	0.009
<b>Social capital</b>				
Sex of HH head	0.109	0.245	0.127*	0.067
Access to extension	- 0.560*	0.212	0.051	0.057
Cooperative member	0.224	0.185	0.058	0.036
<b>Natural capital</b>				
Gurage Zone	0.635	0.359	- 0.354*	0.065
Hadiya Zone	1.992*	0.463	- 0.324*	0.119
Woliyta Zone	0.570	0.253	- 0.293	0.078
Land owned	- 0.011	0.014	0.003	0.002
Land allocated for Enset (%)	- 0.010*	0.006	0.002*	0.001
<b>Physical capital</b>				
Home index	- 0.004	0.005	-0.001	0.001
Farm equipment index	- 0.007*	0.005	-0.002	0.001
<b>Financial capital</b>				
Enset farming	-0.206	0.165	0.055	0.041
Access to credit	- 0.033	0.249	0.104	0.078
Off-farm income	0.117	0.322	0.018	0.063
<b>Vulnerability context</b>				
EXW status	- 1.236*	0.141	-	-
<b>Institutional context</b>				
Access to EXW initiatives	- 0.501	0.328	-	-
Constant	- 0.692	0.779	0.325	0.183

\*P ≤ 0.05

## Conclusion and Recommendations

Human, social, physical and natural capitals and vulnerability context are the most important factors that influence the adoption of the recommended EXW controlling strategies. Decisions of farmers about the extent of adoption is influenced negatively by social and positively by natural capital. Therefore, to increase the adoption of the EXW controlling strategy, understanding and supporting the improvement of livelihood asset is vital. Moreover, to prevent this disease, it is essential to encourage policies that support the continuous adoption of the recommended EXW controlling strategies.

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## Conflict of interests

The author declares that there is no conflict of interest.



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## Author contribution

H. T (100%) conceptualized the study, collected and analyzed data drafted and wrote the manuscript.

## Data and material Availability

The data is included in this report.

## References

- Adane, A. (2018). Status and future prospects of research on diseases of enset (*ensete ventricosum*) and their management. *Ethiop. J. Biol. Sci.* 17(Suppl.): 103–119.
- Ambachew, Z., Gezahegn, B., Sintayehu, L., & Kefelegn, G. (2019). Enset bacteria wilt distribution. *Journal of Environmental system research*, 7:23 <https://doi.org/10.1186/s40068-018-0126-9>
- Belachew, G., Aklilu, A., Bewuketu, H., & Habtamu, K. (2017). Indigenous Knowledge of Enset (*Ensete ventricosum* (Welw.) Cheesman) cultivation and management practice by Shekicho People, Southwest Ethiopia. *Journal of Plant Sciences*. Vol. 5, No. 1, pp. 6-18. doi: 10.11648/j.jps.20170501.12
- Borrell, J. S., Biswas, M. K., Goodwin, M., Blomme, G., Schwarzacher, T., Heslop-Harrison, J., Wendawek, A. M., Berhanu, A., Kallow, S., Janssens, S., Molla, E. L., Davis, A. P., Woldeyes, F., Willis, K., Demissew, S., & Wilkin, P. (2019). Enset in Ethiopia: A poorly characterized but resilient starch staple. *Annals of botany*, 123(5), 747–766. <https://doi.org/10.1093/aob/mcy214>
- Chete, O.B., (2021). Factors influencing adoption of improved maize seed varieties among smallholder farmers in Kaduna State, Nigeria. *Journal of Agricultural Extension and Rural Development*, 13(2), pp.107-114.
- Feyisa, B.W. (2020). Determinants of agricultural technology adoption in Ethiopia: A meta-analysis. *Cogent Food & Agriculture*, 6.
- Fikadu, A., (2020). Impact of row planting teff technology adoption on the income of smallholder farmers: The case of Hidabu Abote District, North Shoa Zone of Oromia Region, Ethiopia. *Int J Agric Sc Food Technol*, 6(2): 195-203. DOI: <https://dx.doi.org/10.17352/2455-815X.000074>.
- García, d., Jalón, S., Iglesias, A., and Neumann, MB. (2018) Responses of sub-Saharan smallholders to climate change: Strategies and drivers of adaptation. *Environ Sci Policy*, 90:38–45
- Kaliba, A.R., Mazvimavi, K., Gregory, T.L., Mgonja, F.M. and Mgonja, M. (2018). Factors affecting adoption of improved sorghum varieties in Tanzania under information & capital constraints. *Agricultural and Food Economics*, 6(1), pp.1-21.
- Kikulwe EM, Kyanjo JL, Kato E, Ssali RT, Erima R, Mpiira S, Ocimati W, Tinzaara W, Kubiriba J, Gotor E, Stoian D, Karamura E (2019) Management of Banana Xanthomonas Wilt: Evidence from impact of adoption of cultural control practices in Uganda. *Sustainability* 11(9):2610
- Kusse, Kutoya & Ermias, Gedion & Darch, Dawit. (2021). Enset Production, Its challenges and controlling methods in South Omo Zone, Southern Ethiopia. *Current Agriculture Research Journal*. 9. 161-170. 10.12944/CARJ.9.3.03.

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- Melaku, T. (2021). KOCHO (Indigenous Food of Ethiopia): A review on traditional practice to scientific developments. *International Journal of Food Science and Nutrition Diet.* 10(7):569-574. doi: dx.doi.org/10.19070/2326-3350-2200098
- Mulatu, E. (2021). What determines Enset (*Ensete ventricosum*) production and its contribution to household income? Empirical evidence from Ethiopia. *Int. J. Agril. Res. Innov. Tech.* 11(1): 17- 25. <https://doi.org/10.3329/ijarit.v11i1.54462>
- Pagnani, T. & Gotor, Elisabetta & Kikulwe, Enoch & Caracciolo, Francesco. (2021). Livelihood assets' influence on Ugandan farmers' control practices for Banana Xanthomonas Wilt (BXW). *Agricultural and Food Economics.* 9. 10.1186/s40100-021-00192-6.
- Shinbrot. X.A., Jones. K.W., Rivera-Castañeda. A., López-Báez W., Ojima. D.S. (2019) Smallholder farmer adoption of climate-related adaptation strategies: the importance of vulnerability context, livelihood assets, and climate perceptions. *Environ Manage* 63(5):583–595
- Yemataw, Z., Mekonen, A., Chala, A., Tesfaye, K., Mekonnen, K., Studholme, D & Sharma, K. (2017). Farmers' knowledge and perception of enset Xanthomonas wilt in southern Ethiopia. *Agriculture & Food Security.* 6. 62. 10.1186/s40066-017-0146-0.
- Zhang, S., Sun, Z., Ma, W., & Valentinov, V. (2020). The effect of cooperative membership on agricultural technology adoption in Sichuan, China. *China Economic Review.* 62. 10.1016/j.chieco.2019.101334.