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Research Application Summary

Performance of mushroom farming enterprise in Eastern Uganda

Kongai, H.[1], Opolot, C.[2] & Oonyu, S.P.[3]

[1]Research and Education Agency, PO Box 29152, Kampala, Uganda

[2]Department of Agribusiness and Extension, Faculty of Agriculture and Animal Science, Busitema University, PO Box 203, Soroti, Uganda

[3]Department of Crop Science, Faculty of Agriculture and Animal Science, Busitema University, PO Box 203, Soroti, Uganda

Corresponding author: hellenbiruma@gmail.com

Abstract

Mushrooms constitute an important source of selenium, potassium, riboflavin, niacin, vitamin D, proteins and fibre. Due to their nutraceutical properties, they are used for prevention of Parkinson, Alzheimer, hypertension and stroke diseases. Despite their importance, prevailing production technologies and techniques as well as high market demand, smallholder farmers are differently adopting their cultivation, thus the need for a study to understand drivers of mushroom cultivation in smallholder production systems. To that effect, a cross-sectional study was carried out in Eastern Uganda to evaluate drivers and economic performance of smallholder mushroom enterprises. The study sample comprised of 60 farmers and two key informants. Both qualitative and quantitative data were collected to facilitate generation of descriptive statistics and gross margins. Findings showed that on average mushroom farmers obtained a gross margin of 1,008,000 shillings (USD 272.4), per production period of about three months at small scale production level of about 50 gardens. The factors affecting mushroom production include lack of production and market information, limited access to quality inputs, high input prices as well as negative attitudes towards mushroom cultivation and cultivated mushrooms. Strategies for unlocking the potential of mushroom cultivation among smallholder farmers, therefore, lie in enhancing information and technologies dissemination.

Key words: Mushrooms cultivation, smallholders production, Uganda

Résumé

Les champignons constituent une source importante de sélénium, de potassium, de riboflavine, de niacine, de vitamine D, de protéines et de fibres. En raison de leurs propriétés nutraceutiques, ils sont utilisés pour la prévention des maladies de Parkinson, d'Alzheimer, de l'hypertension et des AVC. Malgré leur importance, les technologies et techniques de production actuelles ainsi que la forte demande du marché, les petits exploitants agricoles adoptent différemment leur culture, d'où la nécessité d'une étude pour comprendre les moteurs de la culture des champignons dans les systèmes de production des petits exploitants. À cet effet, une étude transversale a été réalisée dans l'Est de l'Ouganda pour évaluer les moteurs et la performance économique des entreprises de culture de champignons des petits exploitants. L'échantillon de l'étude comprenait 60 agriculteurs et deux informateurs clés. Des données qualitatives et quantitatives ont été collectées pour faciliter la génération de

statistiques descriptives et de marges brutes. Les résultats ont montré qu'en moyenne, les producteurs de champignons obtenaient une marge brute de 1 008 000 shillings (272,4 USD) par période de production d'environ trois mois à un niveau de production à petite échelle d'environ 50 jardins. Les facteurs affectant la production de champignons incluent le manque d'informations sur la production et le marché, l'accès limité à des intrants de qualité, les prix élevés des intrants ainsi que des attitudes négatives envers la culture des champignons et les champignons cultivés. Les stratégies pour libérer le potentiel de la culture des champignons parmi les petits exploitants résident donc dans le renforcement de la diffusion d'informations et de technologies.

Mots-clés: culture de champignons, production des petits exploitants, Ouganda

Introduction

Mushrooms are fungi belonging to *Agaricaceae* family. World over, mushrooms are cherished for having low calories, carbohydrates, fat and sodium apart from constituting an important source of potassium, riboflavin, niacin, vitamin D, proteins, and fiber (FAO, 2010;Valverde *et al.*, 2015). Due to their nutraceutical properties, mushrooms are used for prevention and treatment of Parkinson, Alzheimer, hypertension, and high risk of stroke (Valverde *et al.*, 2015). Mushrooms also have great potential for provision of long-term food nutrition, health care, environmental conservation and regeneration as well as socio-economic livelihood sources (Miles and Chang, 2004; Ofodile and Yusuf, 2021).

Across Africa, mushrooms were traditionally picked from the wild; on soil, decaying wood and palm trees at the onset of rains (Anchang, 2014). For instance, Morocco collected several economically important mushrooms from the wild; including the Moroccan matsutake (*Tricholoma caligatum*), *Boletus edulisto*, *Terfezia leonis*, *Tirmania pinoyi*, *Chanterellus cibarius* and *Mochella elata*, for export to Europe, Japan and the Middle East (Ofodile and Yusuf, 2010). The wild edible mushrooms found in Africa constitute over 98 genera (Ofodile and Yusuf, 2010). With the domestication of mushroom production, which started in the 17th Century in France as a thriving industry occupying the abandoned tunnels at the neighborhood of Paris (Thawthong *et al.,* 2014), the trend gradually changed. Aided by various techniques, mushroom cultivation has been progressively rising world over and Africa in particular, with the main mushroom farming countries comprising of Kenya, Nigeria, Uganda, South Africa and Zimbabwe (Ofodile and Yusuf, 2010; Mayanja and Tipi, 2018) Common types of mushrooms cultivated globally include Agaricus, Pleurotus, Lentinula, Auricularia and Flammulina constituting 30%, 27%, 17%, 6% and 5% of output, respectively, coupled with other species contributing 15% of output (Mayanja and Tipi, 2018). Mushroom cultivation provides opportunity for smallholder farmers to diversify to high value intensive farming (Mayanja and Tipi, 2017). Mushrooms cultivation can therefore be viewed as providing great potential for livelihoods improvement among rural communities given the increasing effect of land limitation arising from the rapidly increasing population, associated land degradation and climate change.

China has been the worlds' main producer of mushroom with production level of over 30 billion kilograms compared to 1.3 billion kilograms in the rest of Asia and 3.1 billion kg produced by Europe, America and other countries (Royse *et al.,* 2017). Cultivation of mushrooms in Sub-Saharan Africa (SSA) is still proportionally

minimal compared to other parts of the world. This has been attributed to the nature of SSA's mushroom production sector, which is largely traditional and constrained by poor infrastructure, inadequate technical support, and poor knowledge of mushroom diversity and cultivation techniques (Okhuoya *et al.,* 2010). Consequently, in spite of contributing over 25% of the total mushroom biodiversity worldwide, Africa only contributes about 0.4% of total mushrooms commodity sales on the global market (Yongabi and Achang, 2014).

In Uganda, mushroom farming started in 1989 with the introduction of Oyster mushrooms from Egypt to the National Agriculture Research Laboratories (NARL) Kawanda (Daily Monitor, 2012). Henceforth, Oyster mushrooms continues to be Uganda's most commonly grown mushroom species because of their relative ease of cultivation and minimal investment requirements (Mamiro *et al.*, 2010). The growing demand for mushrooms locally and globally for health, nutritional and medicinal purposes provide great opportunity for mushroom cultivation in Uganda though for decades, it has remained unattractive to farmers necessitating even local demand to be met by imports from South Africa, Britain and elsewhere (Obaa and Nshemereirwe, 2004; Mayanja and Tipi, 2018). In Uganda, mushroom farming can be done in all parts of the country and most local communities use mushrooms for medicinal, soil health improvement and food consumption (Wendiro, *et al.*, 2019). In a semi-arid region like Eastern Uganda in particular, mushrooms can constitute one of the major dry season relish. According to Mayanja and Tipi (2018), mushroom farming is one of the most profitable enterprises undertaken by smallholder farmers as they can yield cash income of about 11.7USD per kilogram when dried, which are returns pertinent to investment of 4.3 USD.

Mushroom producing countries domestically consume their produce (Achang *et al.,* 2014). For instance, China consumes 95% of its mushroom products implying that exports only constitute 5% of the products. Nevertheless, progressive establishment of food distribution systems world over has led to rise of supermarkets in industrialized and developing countries, signing of multilateral, regional and bilateral free trade agreements for agricultural products and emergence of global food supply chains, provide potential for mushroom trade at local, regional and international markets (Hernández *et al.,* 2007; Gold *et al.*, 2008). Literature shows that on a regional basis, mushrooms produced are supplied to institutions (hospitals and hotels), restaurants, greengrocers, superstores, and open-air markets (Gateri *et al.,* 2009). In Uganda, the mushrooms market is apparently readily available for both fresh and dry mushrooms with most of the supplies taken up by supermarkets, hotels, restaurants, and individual consumers (Alex, 2000; Mayanja, 2018). Also, according to Mayanja and Tipi (2017) net profit and returns on mushrooms investment, on average, is favourable. However, in spite of being a profitable undertaking and market demand steadily rising, mushroom farming is diffidently undertaken by smallholder farmers, and this is partly attributed to limited information and research attention given to the enterprise (Malakar *et al.*, 2014). Yet, with the ever-increasing population, the resultant diminishing agricultural land size, associated land degradation, low land productivity and increasing poverty levels (Ferchak and Croucher, 2001), mushroom production provides potential for livelihoods improvement through diversification to high value intensive agricultural production. This study, therefore, assessed drivers and economic performance of mushroom farming in Eastern Uganda so as to provide information to guide strategies for enhancing adoption of mushroom farming in smallholder farming communities in Uganda.

Materials and Methods

The study was carried out in Soroti District. Soroti District covers a total land area of 1,411.9 km^2 with 12 sub-counties. The study respondents involved a cross-section of 60 mushroom farmers and two key informants from Arapai, Gweri, Kamuda, Lale, Western and Eastern divisions of Soroti City. The two Soroti City divisions were included in the study to provide a snap shot of mushroom growing status in the urban-peri-urban settings of Eastern Uganda. Blended sample selection criteria was aimed to ensure inclusion of individuals that had knowledge and experience in mushroom cultivation and marketing. The study sample was selected using multi stage blended random and respondent driven sampling (RDS) criteria. The multi-stage sampling was done to ensure that perceptions of potential mushroom farmers are also taken into account. RDS is a snowball sampling approach aimed to minimise bias in sampling hard-to-reach populations (Kongai *et al.,* 2018). RDS was adapted for selection of mushroom farmers with knowledge and experience on mushroom farming as an income generating activity while random sampling enabled inclusion of potential mushroom farmers into the sample. Sample selection and interview process involved selection of the initial respondent at each subcounty who was interviewed and in turn provided a list for subsequent respondents' selection. Random sampling on the other hand was tused at different stages of the study to obtain other respondents without necessarily following the provided respondents' lists for selecting respondents. Both qualitative and quantitative research methods were applied in for data collection so as to obtain individual and community perspectives on mushroom farming. The data were collected using pretested questionnaires and interview schedules. Data analyses was carried out using the Statistical Package for Social Sciences (SPSS) version 20 to generate descriptive statistics for explaining the study findings. In addition, gross margins were computed to provide information on financial performance of mushroom farming among smallholder farmers.

Results and Discussion

Respondents' socioeconomic characteristics. The study involved 62 respondent of whom 38% were female. Majority (28.3%) of the respondents were from Lale Sub-county followed Gweri (25.0%) and Kamuda (21.7%) (Table 1). Most (80.0%) of the respondents were married majority of them being business practitioners as shown by 50.0% of the respondents followed by farmers constituting 30% of the respondents (Table 1).

The household size of respondents ranged from 3 to 16 members with an average of 7.7 members per household (Table 2). This finding implies that household population pressure is relatively high in the Eastern part of the country compared to the national average which stands at 5 people per household (Uganda National Bureau of Statistics, 2019/2020). A large household size usually exerts more pressure on household resources thus affecting investment and livelihood sustenance. Nevertheless, a large number of people in the household could provide household labour for diversification of livelihood sources. Obi and Pote (2012) similarly observed that a larger household size may increase labour available for increasing output and ultimately expand income generation through the market. In that regard, household members ought to be empowered to recognise the opportunity of household size so as to take advantage of the benefits it presents for diversification of farm income sources (Kongai *et al.,* 2020).

Table 1. Respondents' location, marital status and major employment

Gender Location	Female		Male		Total	
	F	%	F	%	F	%
Arapai	2	3.3	2	3.3	4	6.7
Eastern Division	1	1.7	3	5.0	4	6.7
Kamuda	9	15.0	4	6.7	13	21.7
Lale	5	8.3	12	20.0	17	28.3
Gweri	2	3.3	13	21.7	15	25.0
Western division	4	6.7	3	5.0	7	11.7
	23	38.3	37	61.7	60	100.0
Marital Status						
Married	20	33.3	28	46.7	48	80.0
Single	3	5.0	9	15.0	12	20.0
	23	38.3	37	61.7	60	100.0
Major employment						
Runing business	11	18.3	19	31.7	30	50.0
Formal job	5	8.3	7	11.7	12	20.0
Farming	7	11.7	11	18.3	18	30.0

Table 2. Household size and age

Attribute	Female		Male		Total	
	Mean	SD	Mean	SD	Mean	SD
Household size	8.87	3.817	7.03	3.346	7.73	3.617
Age of farmers	45.04	13.148	42.43	11.603	43.43	12.176

The age of respondents ranged from 23 to 70 years with the average age standing at 43.43 years implying that mushroom farmers are middle age adults (Table 2). According to Abafita *et al*. (2016) younger farmers have better ability to obtain, process and use information thus providing greater potential for adoption of mushroom farming which is in line with the Government of Uganda's Development Plan 4 of addressing the problem of high population and resultant degradation of agricultural land by transforming agriculture through diversification to environmentally friendly food production (Ministry of Local Government, 2021). FAO (2010) similarly observed that with a high population of people living below the poverty line, the cost effective option for improving health and reducing food insecurity could be diversifying to mushroom farming.

Majority (46.7 and 41.7%) of the respondents attained primary and tertiary education levels, respectively (Table 3). This finding suggests that exists a large bridging gap between primary and tertiary education. Besides, across gender comparison results showed that more (26.7%) men have tertiary education compared to women (15%). This could be consequent to marginalization of women arising from structural constraints. Across subcounty compari-

son results show that Arai, Eastern Division, Kamuda and Western Division have a vivid gap in secondary education as respondents registering attainment of secondary education were missing (Table 3).

Table 3: Education level

Gender	Primary		Secondary		Tertiary		Total	
	F	%	F	%	F	%	F	%
Female	13	21.7	1	1.7	9	15.0	23	38.3
Male	15	25	6	10.0	16	26.7	37	61.7
Total	28	46.7	7	11.7	25	41.7	60	100
Subcounty								
Arapai	1	1.7	0	0'0	3	5.0	4	6.7
Eastern division	1	1.7	0	0.0	3	5.0	4	6.7
Gweri	6	10.0	5	8.3	4	6.7	15	25.0
Kamuda	9	15.0	0	0.0	4	6.7	13	21.7
Lale	9	15.0	2	3.3	6	10.0	17	28.3
Western division	2	3.3	0	0.0	5	8.3	7	11.7
Total	28	46.7	7	11.7	25	41.7	60	100

Mushroom farmers constituted 61.7% of the study respondents of whom, 58.1% were female. Most (45.2%) of the farmers managed less than 50 gardens of mushrooms followed by 29% who managed 50 to 100 gardens (Table 4). Across gender comparison results showed that a higher proportion (32.3%) of the women managed less than 50 gardens compared to only 12.9% of their male counterparts (Table 4). This could be because men are better endowed in terms of resources hence the ability to finance alternative and relatively higher level of investment options compared to women.

Table 4. Mushroom production scale

	Female		Male		Total	
No. of gardens	F	%	F	%	F	%
< 50	10	32.3	4	12.9	14	45.2
50 – 100	4	12.9	5	16.1	9	29.0
100 – 200	2	6.5	1	3.2	3	9.7
200 400	1	3.2	3	9.7	4	12.9
> 400	1	3.2	0	0	1	
Total	18	58.1	13	41.9	31	100

Mushroom cultivation among smallholders is mainly done for income generating purposes as shown by 93.5% of the respondents (Table 5). Majority (86.8%) of the respondents had less than three years' mushroom farming experience (Table 5). Apparently, more (51.6%) women are diversifying to mushroom farming given that they have less than four years of mushroom farming experience compared to 32.3% of the men in the same category (table 5). This could be because mushroom cultivation favours women who due to structural dynamics have limited access to land. Similar observations were made by Mayanja and Tipi (2017) and and Obaa

and Nshemereirwe, 2004, while assessing mushroom farming in the central region of Uganda. Mushroom farming generally offers great opportunity for household income generation on full or part-time employment basis among the disadvantaged and marginalized people in both peri-urban and rural areas where access to land significantly constrains agricultural production (Ferchak and Croucher, 2002)

Table 5. Mushroom cultivation experience and purpose

No. of years	Female		Male		Total	
	F	%	F	%	F	%
1 year	5	16.1	0	0.0	5	16.1
2 years	5	16.1	8	25.8	13	44.9
3 years	6	19.4	2	6.5	8	25.8
4 years	0	0.0	0	0.0	0	0.0
5 years	0	0.0	2	6.5	2	6.5
6 years	2	6.5	0	0.0	2	6.5
7 years	0	0.0	1	3.2	1	3.2
Total	18	58.1	13	41.9	31	100
Production purpose						
Cash income earning	16	51.6	13	41.9	29	93.5
Subsistence	2	6.5	0	0.0	2	
Total	18	58.1	13	41.9	31	100.0

The average annual production results show that mushroom production is steadily rising with an annual growth rate of about 10%. The progressive marginal output of 375.2 kilograms in 2021 and that of 383.3 kilograms in 2022 similarly, show progressive growth in mushroom production (Table 6). This may be attributed to the mushroom cultivation promotional activities of NGOs and the Government in a bid to increase food security (Ministry of Local Government, 2021). Mushrooms productivity on the other hand, based on farmers' perceptions was estimated to range from 2 to 2.5 kilograms per garden per production cycle (about 3 months). Consequent to data limitations however, interpretation of this finding ought to be limited to that context thus necessitating field experimentation for collection of appropriate data to facilitate appropriate analysis.

Table 6. Annual mushroom production statistics for the years 2020 – 2023 in kilograms

Year	Female		Male		Total	
	Mean	SD	Mean	SD	Mean	SD
2023 (partial)	1082.2	2018.0	2023.1	2185.8	1476.8	2107.5
2022	1387.1	1384.8	2014.2	2268.8	1650.1	1801.3
2021	1003.8	1626.6	2402.3	5305.4	1590.2	3640.1
2020	628.6	1453.6	1572.3	4073.7	1024.4	2838.9

Mushroom trade. Apparently all the mushroom produced was traded on locally. The trade mechanisms entailed hawking, open market sales and direct delivery to consumers in response to telephone calls. Majority (63.3%) of the farmers sold their mushroom produce to final consumers (Table 6). Across gender comparison results show that 41.9% of the women sold their mushroom produce to final consumers compared to 22.6% of the men. Generally, 25% of the respondents sold their mushroom produce to retailers and no significant differences existed between women and men that sold their produce to retialers. Similarly, earlier studies in Uganda showed that mushroom farmers supply their produce to supermarkets, local market and road sides traders, and hawkers (Obaa and Nshemereirwe, 2004; Mayanja and Tipi, 2018). The average price of mushroom output was found to be 10,000 shillings (USD 2.7) per kilogram of fresh mushrooms and 50,000 shillings (USD 13.5) per kilogram of dry mushrooms.

Factors affecting mushroom farming. The study showed that factors affecting mushroom farming include poor quality of spawns and substrates, negative attitudes towards cultivation and cultivated mushrooms, limited supply of raw materials, limited extension, high prices of raw materials, low output prices, limited market and lack of capital for mushroom production investment. Overall, limited information, high prices of raw materials, limited supply of inputs and poor quality of spawns and substrates were the most deterrent factors as indicated by 40, 30, 11 and 9% of the respondents (Figure 1). Elsewhere, lack of appropriate technologies' information has been reported to lead to farmers incurring high costs to produce poor quality output (Dorward and Kydd, 2005). Also, making decisions without information on product quality, quantity and associated market requirements places smallholders in compromising positions when it comes to timing and pricing of their produce (Bienabe *et al.,* 2004). It has generally been observed that information flow among smallholders could be facilitated through their social networks, however, majority of respondents 94.1% did not belong to any organized farmer group/cooperatives thus highlighting need to facilitate strategic interactions among mushroom farmers information flow or enhancement among mushroom farming farmers. Besides, 11% of the respondents observed that there was shortage in supply of raw materials/inputs for mushroom farming. Henceforth, in compliance with the law of demand and supply, farmers encountered high input prices as indicated by 30% of the respondents. High input prices lead to farmers opting to do without or buy less of the inputs due to competing demands for limited resources (Sanchi and Alhassan, 2022). This calls for interventions targeted to improve availability and affordability of inputs for enhancing smallholder diversification to mushroom farming.

Economic performance of smallholder mushroom farming. Findings showed that cost items that generated fixed costs for mushroom farming include tumplines (polythene sheets), watering cans, metallic drums, housing, weighing scales and shelves, but mainly applied to those who produced mushroom on a relatively large scale. The variable cost items comprised of polythene bags for preparation of gardens, labour, water, substrates, firewood, spawns and material for packaging produce. Based on individual estimates corroborated by Key informants, farments require total investment of about 640,000 shillings to produce 125 kilograms of mushrooms (Table 7). Variable costs constitute about 38% of the required total investment (Table 7).

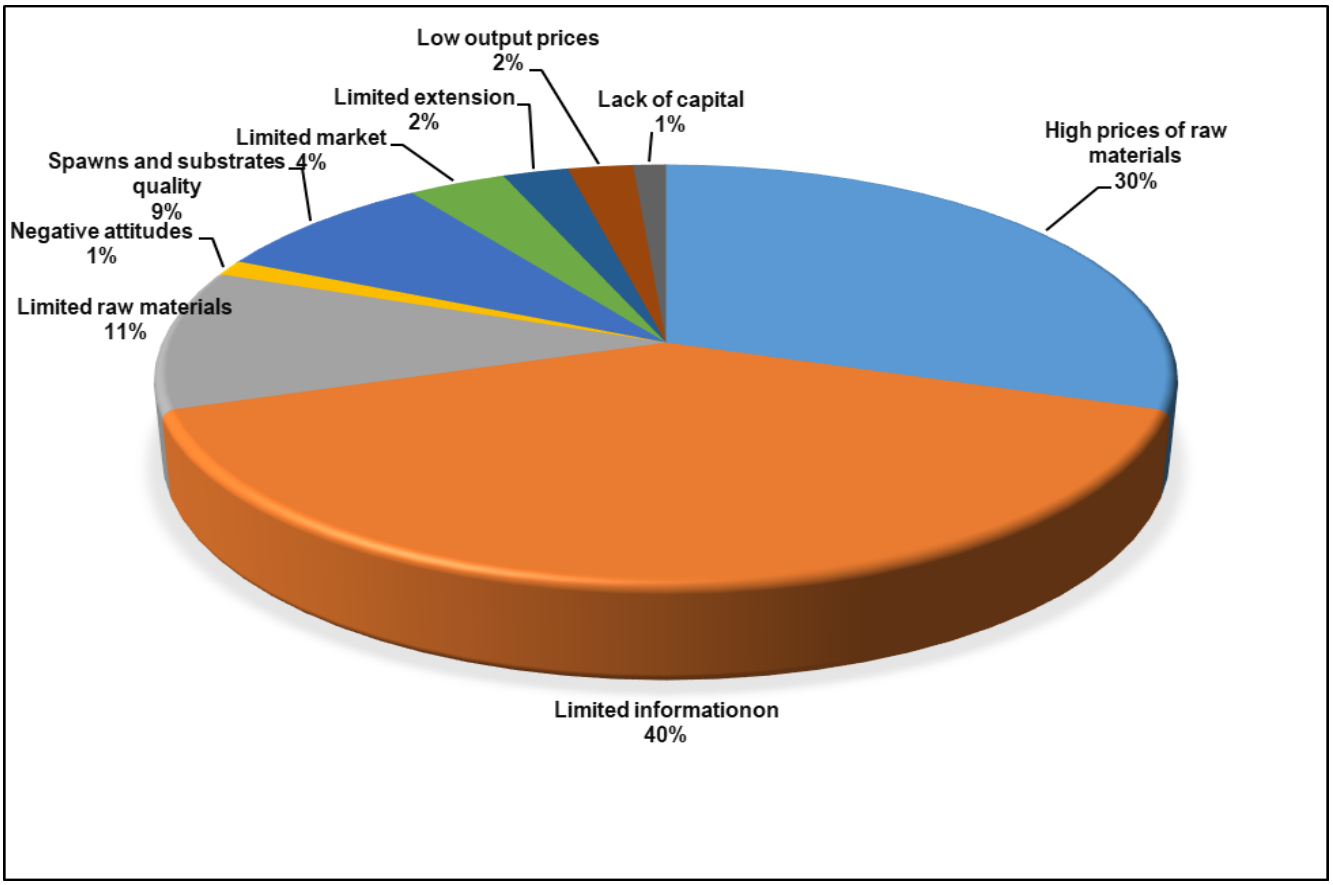

Table 7. Estimated costs of materials for producing125 kilograms of mushrooms

Item	Quantity	Unit Price UGX	Total Amount UGX
Substrates	1bag	110000	110,000
Spawns	12	5000	60,000
Firewood	2 bundles	2500	5,000
Polythene bags	2packs	2000	4,000
Labor		30000	30,000
Water			18,000
Containers	1dozen	15000	15,000
Variable costs			242,000
Weighing scale	1	50000	50,000
Shelf	1	20000	20,000
Solar dryer	1	100000	100,000
Housing		80000	80,000
Metallic drum	1	85000	85,000
Watering can	1	10000	10,000
Turpline	1	50000	50,000
Fixed costs			395,000
Total costs			637,000

The total operational costs per kilogram of mushroom, therefore, is approximately 38% indicating that small-holder mushroom production is relatively efficient. The benefit cost analysis results showed that farmers earn

a gross marketing margin of 1,008,000 shillings when appropriately managing about 50 mushroom gardens (Table 8). The gross margin percentage is 81% implying that, other factors held constant, smallholder farmer can multiply their income by over 8 times at an investment level committed to operate 1 – 50 gardens of mushroom. Mushrooms cultivation, therefore, present lucrative income generating opportunities for both rural, peri-urban and urban smallholder farmers. These observations were similarly made by Obaa and Nshemereirwe 2004 and Mayanja and Tipi 2018.

Table 8. Benefits cost analysis for production of 125 kilograms of fresh mushrooms

Particulars	Average (kg/Ug shillings)
Total output (estimated)	125
Average output price	10,000
Total Revenue	1250000
Total variable costs	242000
Gross marketing margin	1,008,000

Conclusion and Recommendations

The evaluation of mushroom cultivation in Eastern Uganda has revealed that mushroom cultivation is majorly a women enterprise that is growing at an annual rate of about 10%. With relatively low investment approximated at 650,000 shillings (USD 175.7) a farmer can realise a gross margin of 1,008,000 shillings (USD 486.5) per cycle of about 3 moths thus realising a gross margin percentage of over 80% per 3 months period. The main constraints to mushroom cultivation include limited information and quality inputs, and high input costs. In order to boost the smallholder mushroom enterprise in Eastern Uganda, strategic interventions ought to be focused on facilitating mushroom farming information and technologies dissemination.

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