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The sustainability analysis of *Allium cepa* conventional farming using multi-dimensional scaling in Jeneponto, South Sulawesi, Indonesia

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Abstract

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The aims of this study were: to analyze the sustainability of shallot farming in Jeneponto and to analyze the sensitivity attributes of shallot farming sustainability in Jeneponto. Shallot farming sustainability analysis was performed using the Multi-Dimensional Scaling (MDS) approach. Based on analysis results, the overall sustainability status of onion farming in Jeneponto is fairly sustainable (54.68%) accumulated from the fairly sustainable score (64.31%, 52.96%, 55.18%) in social, economy, and technology dimensions respectively while on the contrary, less sustainable score (46.26%) was observed from the institution dimension. The results of the study suggested that the leverage attributes which is sensitive to shallot farming sustainability encompass: 1) labor availability; 2) farmer-to-farmer interaction; 3) industrial availability; 4) use of superior variety; 5) use of agricultural machinery; 6) organic fertilization; and 7) post-harvest processing. These leverage attributes must be prioritized by the stakeholders through the planning and implementation of appropriate policies to maintain shallot farming sustainability in Jeneponto.

Keywords: sustainability; allium cepa; multi-dimensional scaling

Introduction

Shallot as a commodity plays an important role in human life all around the world. It is one reason why farmer communities are still interested in shallot cultivation. Such importance is reflected in the total area dedicated to shallot farming which accounts for 5.7 mln ha with annual production reaching 109 mln t (FAO, 2020). Shallots have high economic value represented by the increasing domestic and foreign demand and increasing exports. It is one common commodity used as a spice in cooking (Kuete, 2017), a natural preservative, and a good source of antioxidants (Al-Ansari et al., 2023; Mardani et al., 2023). It also has benefits for health (Banerjee et al., 2022) and can be used to treat various human diseases.

Shallot is widely cultivated by farmers in dryland areas (Assefa et al., 2016), lowlands to highlands (Xie et al., 2020), areas with limited water availability, high air temperature, low humidity, and dry tropical areas (El Balla et al., 2013) like Jeneponto, South Sulawesi, Indonesia. Shallots can grow in both the lowlands and in lands at altitudes ranging from 0-1568 MASL. Shallots are sensitive to rainfall, high rain intensity, and foggy weather. South Sulawesi has tropical climate conditions and the landscape presents a supportive environment for shallot growth (Rosliani et al., 2015). A considerable number of farmers rely on shallots as their main source of income in this region (Darwanto & Waluyati, 2019; Gunawan et al., 2021).

Shallot farming mostly still applies the conventional system. These conventional farming practices include chemi-

cal fertilizers and pesticide use without considering their harmful impact on health and the environment (Raimondi et al., 2023). To expand future shallot production, it is necessary to transform conventional systems into modern farming systems supported by technology. Modern farming systems will enable farmers to increase their production and income (Astati et al., 2023). South Sulawesi is one of the strategic areas to develop massive shallot farming and holds a greater potential as an export commodity.

Shallot commodity also plays an important role as a contributor to a national foreign exchange. Land condition at the research site in Jeneponto (5.5546°S, 119.6731°E) indicates characteristics including a dry climate with only 3–5 wet months/year with an average rainfall of 397.3 mm/year, and an average temperature of 27°C-32°C. Frequently, long dry periods of 5–6 months/year also occurred. In fact, in 2021, a dry period occurred from May to early November (Central Bureau of Statistics of Indonesia, 2021). However, in the last 3 years, shallot production has fluctuated in South Sulawesi (2018-2021). Production fluctuations also affect prices among the farmers (Central Bureau of Statistics of Indonesia, 2023). These fluctuating conditions are caused by climatic conditions and may require further research. Unfavorable climatic conditions combined with low production have contributed directly to farmer's income level which tends to decline. Based on these facts, further investigation through an economic perspective is considered necessary. Declining production and income were also promoted by the low level of institutional strength. Investigating the institutional dimension of shallot farming activity in Jeneponto is important as well. A strong correlation between institutions as a social factor or weak farmer cooperation indicates the need to study the social dimension. Weak institutional factors due to the lack of information technology role had also become an indication of the need to research sustainability from the perspective of the technological dimension.

From the above facts, to address the issue, the research objectives need to be determined. The objectives include analyzing the fluctuation causes based on the social, economic, technological, and institutional dimensions.

Materials and Methods

This research was conducted in Jeneponto, South Sulawesi from September to November 2022. The collected data in this study include primary and secondary data. Primary data were collected by interviewing 60 farmers using questionnaires. Secondary data were collected from reports presenting relevant information to the present study objectives from many institutions. Data collection employs surveys and literature studies. The survey was performed to collect primary data involving interviews (with the farmers, farmers group, extension consultant, and stakeholders) and observation (direct observation) at the research site. On the other hand, a literature study is used to collect secondary data from the relevant documents related to the present study objectives.

Data Analysis

Sustainability analysis of shallot farming employed descriptive statistics analysis using IBM SPSS 26 software (Pallant, 2020) using Multi-Dimensional Scaling (MDS) approach (Saeed et al., 2018). The scores for each attribute were analyzed using Multi-Dimensional Scaling (MDS) to determine the category reflecting sustainability status based on two reference categories (good and very poor). The estimated score for each dimension can be started from a scale of 0% as the worst (very poor) and best (good) at a scale of 100%. The score representing the index value of sustainability from each dimension is presented in Table 1.

Table 1. Shallot farming sustainability status category based on the analysis index value

Index Value	Category
0.00–25.00	Very Poor (non-sustainable)
25.01–50.00	Poor (less sustainable)
50.01–75.00	Fair (fairly sustainable)
75.01–100.00	Good (sustainable)

Results and Discussion

Multidimensional Analysis of Shallot Farming in Jeneponto

The results of the MDS analysis indicated that the *index* value of shallot farming sustainability in Jeneponto Regency accounts for 54.68%. The score was obtained from an assessment of four dimensions including the social, economy, technology, and institution dimension with a total of 18 attributes. By assessing the figure (54.68%), the index value of multidimensional sustainability falls under the fairly sustainable category as the index value is within the range of 50.01–75.00.

The results of the analysis show that the sustainability *index* from the social dimension accounts for 64.31% (fairly sustainable); the economic dimension is 52.96% (fairly sustainable), the technological dimension is 55.18% (fairly sustainable), and the institutional dimension is 46.26% (less sustainable). The *index* value of each sustainability dimension is presented in the following kite diagram in Figure 1.

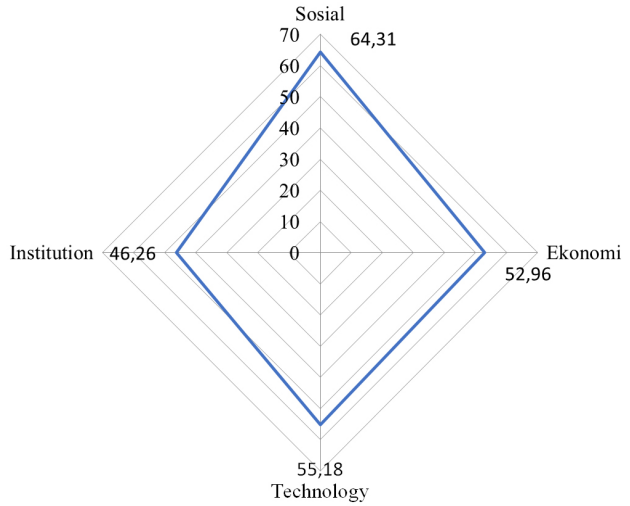

Fig. 1. Sustainability dimension index of shallot farming in Jeneponto

The sustainability *index* value of shallot farming in Jeneponto showed a fairly sustainable status (Figure 1). This may be promoted by various factors, for example, shallot's common use as a food ingredient in various dishes or high demand from the local market. This will ensure shallot farming businesses have a stable market (Pratiwi et al., 2019). In addition, the shallot is a food material and people use it daily which implies a consistent annual demand for shallot. Shallots also have relatively good storability and can be stored for quite a long time (El-Tantawy & El-Beik, 2009). This allows farmers to maintain the supply and the sales of shallots in an accurate period for maximum profit. Shallot cultivation can provide a stable income for farmers. With good profits, farmers can maintain their business and invest more to increase shallot productivity and quality.

Leverage Analysis of Shallot Farming Sustainability

The results of the leverage analysis on social attributes show that all social attributes are sensitive to the sustainability *index*. To improve the sustainability of these attributes in the future, intervention or improvement is required.

Social Dimension of Shallot Farming

As can be seen from the social dimension approach, the order of the attributes from the highest to the lowest is as follows: farmer's welfare, government policy and facility support, gender participation, community relation, farmer-to-farmer interaction, and labor availability. This can be seen in Figure 2 as follows.

From the analysis results, the most sensitive attribute affecting the social dimension of sustainability is labor availability (Figure 2). Labor availability at the research site is currently abundant. Jeneponto is located in South Sulawesi and is one of the regions famous for shallot production. Jeneponto has a population of around 284 000 people. The majority of the population works in the agricultural sector and the population will increase by approximately 1.5% in 2023 (Central Bureau of Statistics of Indonesia, 2023; Gao et al., 2023). The low level of education in the region is another issue in the efforts of improving labor quality. However, a considerable part of the local community in Jeneponto has skills and experience in agriculture. Therefore, they can become reliable workers in shallot farming.

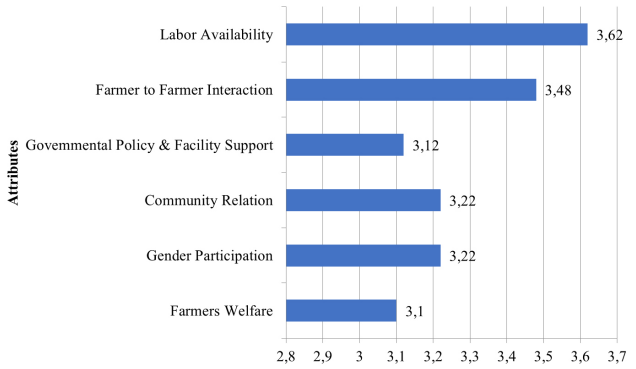

Fig. 2. Sensitive Attribute of Social Dimension

The existence of shallot farming in Jeneponto has a positive influence on the community. This can be seen from the sensitivity of farmer-to-farmer interaction (Figure 2). However, it can be observed that the lowest attribute is the farmer's welfare. The level of farmers' welfare is still minimum. This is probably due to the government's lack of concern with supplying farmers with appropriate seed varieties for their farms and region. Current policies also tend to neglect the farmers. Improvements can be made to upgrade the index and social dimension sustainability status. The role of the government in providing farmers with varieties suitable to regional climate is very important. This is because appropriate varieties produce better harvests, improve crop quality and productivity, and decrease the risk of crop failure (Sang et al., 2023; Wicaksono et al., 2022). This can be done by researching and developing local tolerant varieties against stresses from the weather and diseases common to the region. The government can provide farmers with training and extension services on how to plant and care for crops adapting to the regional climate (Yorobe et al., 2011) or provide incentives and subsidies to farmers to buy varieties that are appropriate to the regional climate (Khonje et al., 2022). These incentives and subsidies will accelerate the adoption

of varieties more appropriate to the regional climate and increase farmers' income (Bibi et al., 2021).

Economy Dimension of Shallot Farming

The result shows that the attributes of the economic dimension ranked from the lowest to the highest are competition, market availability, and industry availability respectively. The result is presented in Figure 3 as follows.

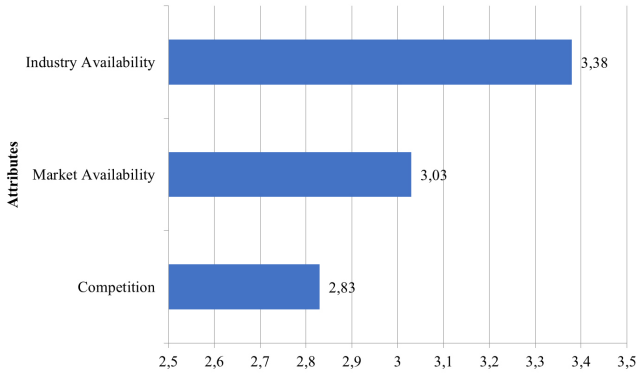

Fig. 3. Sensitive Attribute of the Economic Dimension

The availability of various products in the shallot farm business in Jeneponto is essential to maintain because shallot is one of the agricultural commodities with high demand in Indonesia. Shallot is widely used in cuisine and contains nutrients that are good for health (Lola-Luz et al., 2014). Shallot also improves metabolism with its high-level secondary compound because it contains bioactive properties (Kumar et al., 2022). Moreover, the shallot farm business provides significant benefits to Jeneponto economies (Figure 3). Shallot farming can increase farmers' income and encourage economic growth in the region (Yeshiwas et al., 2023). Thus, maintaining product availability in the shallot farming business will help increase welfare and will reduce dependency on imported shallot.

In addition to economic benefits, shallot farming provides significant environmental benefits. Sustainable and environmentally friendly farming maintains the soil fertility and biodiversity of the region. Therefore, maintaining product availability in the shallot farm business will also help maintain the sustainability of both the environment and agricultural production. The low competition attribute necessitates improvement to ensure the sustainability of the shallot farm business in Jeneponto (Figure 3). Several strategies can be implemented to reduce price competition between shallot farmers (Etienne et al., 2023; Mila et al., 2022) including forming farmer groups; establishing cooperation with collectors or agents; improving products quality; opening alternative distribution channels; and participating in training and extension services (Norton & Alwang, 2020).

Technology Dimension of Shallot Farming

The result shows that the shallot farm business still needs improvement in irrigation as can be seen from its attribute value of 2.97. This value indicates that the shallot farm business falls into the fair category. Meanwhile, the other 4 attributes, organic fertilization, use of the superior variety, and use of agricultural machinery fall into the good category and must be maintained. This can be seen in Figure 4.

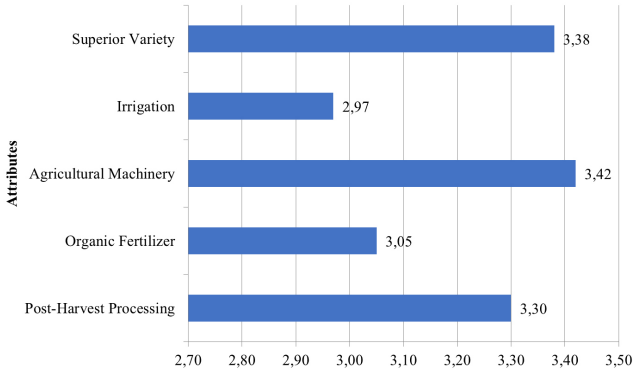

Fig. 4. Sensitive Attribute of Technology Dimension

In Jeneponto, technology can play an important role in shallot development and production. Post-harvest processing is essential to extend shelf life, increase value-added products, and decrease post-harvest loss in the shallot farm business in Jeneponto (Figure 4). Several important steps in shallot post-harvest processing are: Harvesting by determining the proper time in which the leaves turn yellow and withered. The aim of this timing is also to prevent bulb damage (Peters, 2018); Sorting by separating bad or damaged yields (Sule, 2019); Drying in shady and well-ventilated places; Cleaning shallot carefully to prevent damage; Storing in dry and dark storage (Ridolfi et al., 2018); Packaging using clean and durable containers to maintain product's safety and quality during delivery and storage; Advanced processing such as by milling or making shallot into powder (Guillard et al., 2018) or paste (Sukasih & Musadad, 2018).

The lowest attribute is irrigation (Figure 4). An integrated approach and effective strategy are needed to address the irrigation problem in dry lands. Some alternative steps include Assessing crop's water needs in dry areas such as Jeneponto (Volaire, 2018); Conserving water to maximize water use efficiency (Moglia et al., 2018), for example by covering the soil with organic or inorganic mulch to reduce evaporation; Implementing micro irrigation system by watering crops

directly into their roots; Reducing water loss due to evaporation (Zheng et al., 2018) and using rainwater (Ibrahim et al., 2019); Selecting drought resistant varieties (Ilyas et al., 2021). By maximizing these attributes, the technological dimension can be sustainable.

Institution Dimension of Shallot Farming

The result shows that attributes that need improvements are farm business cooperatives and the availability of microfinance institutions. Respectively, each has a value of 2.57 and 2.82. Both attributes fall into the fair category. The other two attributes are the availability of culture and local wisdom, and agricultural extension services need to be maintained.

The attributes of farm business cooperatives and the availability of microfinance institutions need improvement to be sustainable. Farmer's access to cooperative and microfinance institutions can facilitate shallot farmers in Jeneponto with financial assistance and market access (Figure 5). Some alternatives steps that can be taken are providing education and training to farmers on effective and efficient farming techniques, business management, selection of good variety, proper use of fertilizer, and pest and disease control (Amfo & Ali, 2020; Bagheri et al., 2019; Wang et al., 2019). In addition, providing extension services and consultation that can provide advice and guidance in decision-making, monitor crop development, and provide solutions when problems occur. Access to microfinance institutions, such as cooperatives or micro banks that can aid farmers with working capital loans and other financial services (Svetlana et al., 2018) is crucial to shallot farmers in Jeneponto. Moreover, other important steps such as marketing, distribution channels, and collaborative networks that collaborate between farmers and local traders, build a relationship with modern markets and widen access to the market through e-commerce or digital platforms (Anshari et al., 2019).

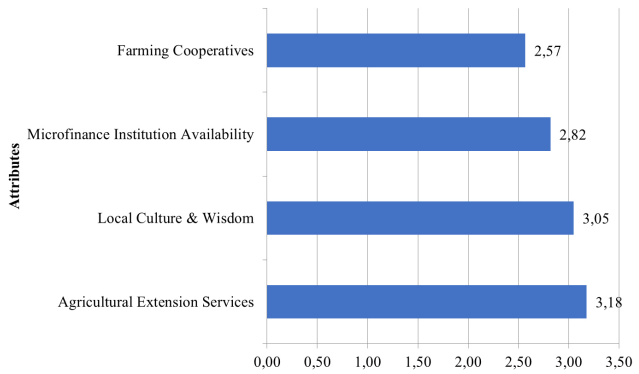

Fig. 5. Sensitive Attribute of Institution Dimension

Conclusion

The study shows that the sustainability status of shallot farm business in Jeneponto Regency falls into the fair category (54.68%). Such result was accumulated from social dimension 64.31% (fair); economy dimension 52.96% (fair), technology dimension 55.18% (fair), and institution dimension 46.26% (poor). This study holistically explains several aspects or attributes (social, economy, technology, and institution) that are the determining factors and reference to develop a shallot farm business sustainability program in Takalar Regency. The leverage attributes with very sensitive influence on shallot farm business sustainability are 1) Availability of workforce; 2) Interaction with other farmers; 3) Availability of industry; 4) Use of superior variety; 5) Use of agriculture machinery; 6) Organic fertilization; and 7) Post-harvest processing. These seven leverage attributes must receive priority from stakeholders through suitable policy making and implementation to ensure the sustainability of the shallot farm business Jeneponto Regency is maintained.

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Conflict of Interest

We declare that there is no conflict of interest starting from the field research up to the writing process of this manuscript.

References

Al-Ansari, M. M., Al-Humaid, L., Aldawsari, M., Abid, I. F., Jhanani, G. K. & Shanmuganathan, R. (2023). Quercetin extraction from small onion skin (*Allium cepa* L. var. *aggregatum* Don.) and its antioxidant activity. *Environmental Research*, *224*, 115497. https://doi.org/10.1016/J.ENVRES.2023.115497.

Amfo, B. & Ali, E. B. (2020). Climate change coping and adaptation strategies: how do cocoa farmers in Ghana diversify farm income? *Forest Policy and Economics*, *119*, 102265.

Anshari, M., Almunawar, M. N., Masri, M. & Hamdan, M. (2019). Digital marketplace and FinTech to support agriculture sustainability. *Energy Procedia*, *156*, 234–238.

Assefa, S., Biazin, B., Muluneh, A., Yimer, F. & Haileslassie,

A. (2016). Rainwater harvesting for supplemental irrigation of onions in the southern dry lands of Ethiopia. *Agricultural Water Management*, *178*, 325–334. https://doi.org/10.1016/j.agwat.2016.10.012.

Astati, Siregar, A. R., Hastang & Paly, M. B. (2023). Study on identification of micro environment factors in fattening business development Bali Cattle in Barru Regency South Sulawesi Indonesia. *International Journal of Sustainable Development and Planning*, *18*(3), 985–990. https://doi.org/10.18280/ijsdp.180335.

Bagheri, A., Bondori, A., Allahyari, M. S. & Damalas, C. A. (2019). Modeling farmers' intention to use pesticides: An expanded version of the theory of planned behavior. *Journal of Environmental Management*, *248*, 109291.

Banerjee, N., Biswas, S., Hossain, C. M. & Basak, P. (2022). Effectiveness of onion (*Allium cepa* L.) skin in human health. In: *Contemporary Medical Biotechnology Research for Human Health,* 115-125. *Academic Press*. https://doi.org/10.1016/B978-0-323-91251-8.00003-9.

Bibi, N., Shah, M. H., Khan, N., Mahmood, Q., Aldosari, A. A. & Abbasi, A. M. (2021). Analysis and health risk assessment of heavy metals in some onion varieties. *Arabian Journal of Chemistry*, *14*(10), 103364. https://doi.org/10.1016/J.ARABJC.2021.103364.

Central Bureau of Statistics of Indonesia (2021). Jeneponto Regency in Numbers 2021.

Central Bureau of Statistics of Indonesia (2023). Statistical Yearbook of Indonesia 2023. https://sulsel.bps.go.id/indicator/55/1096/1/produksi-bawang-merah-provinsi-sulawesi-selatan-menurut-kabupaten-kota.html.

Darwanto, D. H. & Waluyati, L. R. (2019). Farmer's behavior towards Lembah Palu shallot farm risks in Central Sulawesi, Indonesia. *EurAsian Journal of BioSciences*, *13*(2), 931–936.

El-Tantawy, E. M. & El-Beik, A. K. (2009). Relationship between growth, yield and storability of onion (*Allium cepa* L.) with fertilization of nitrogen, sulphur and copper under calcareous soil conditions. *Research Journal of Agriculture and Biological Sciences*, *5*(4), 361–371.

El Balla, M. M. A., Hamid, A. A. & Abdelmageed, A. H. A. (2013). Effects of time of water stress on flowering, seed yield and seed quality of common onion (*Allium cepa* L.) under the arid tropical conditions of Sudan. *Agricultural Water Management*, *121*, 149–157. https://doi.org/10.1016/J.AGWAT.2013.02.002.

Etienne, X. L., Farhangdoost, S., Hoffman, L. A. & Adam, B. D. (2023). Forecasting the U.S. season-average farm price of corn: Derivation of an alternative futures-based forecasting model. *Journal of Commodity Markets*, 100333. https://doi.org/10.1016/J.JCOMM.2023.100333.

FAO (2020). Food and Agriculture Organization of the United Nations. In: *Rome, Italy*.

Gao, P., Xie, Y., Song, C., Cheng, C. & Ye, S. (2023). Exploring detailed urban-rural development under intersecting population growth and food production scenarios: Trajectories for China's most populous agricultural province to 2030. *Journal of Geographical Sciences, 33*(2), 222-244.

Guillard, V., Gaucel, S., Fornaciari, C., Angellier-Coussy, H., Buche, P. & Gontard, N. (2018). The next generation of sustainable food packaging to preserve our environment in a circular economy context. *Frontiers in Nutrition*, *5*, 121.

Gunawan, E., Perwita, A. D., Sukmaya, S. G., Darwis, V. & Ariningsih, E. (2021). The competitiveness analysis of shallot in Indonesia: A Policy Analysis Matrix. *Plos One*, *16*(9), e0256832.

Ibrahim, G. R. F., Rasul, A., Ali Hamid, A., Ali, Z. F. & Dewana, A. A. (2019). Suitable site selection for rainwater harvesting and storage case study using Dohuk Governorate. *Water*, *11*(4), 864.

Ilyas, M., Nisar, M., Khan, N., Hazrat, A., Khan, A. H., Hayat, K., Fahad, S., Khan, A. & Ullah, A. (2021). Drought tolerance strategies in plants: a mechanistic approach. *Journal of Plant Growth Regulation*, *40*, 926–944.

Khonje, M. G., Nyondo, C., Mangisoni, J. H., Ricker-Gilbert, J., Burke, W. J., Chadza, W. & Muyanga, M. (2022). Does subsidizing legume seeds improve farm productivity and nutrition in Malawi? *Food Policy*, *113*, 102308.

Kuete, V. (2017). *Allium cepa*. Medicinal Spices and Vegetables from Africa: Therapeutic Potential Against Metabolic, Inflammatory, Infectious and Systemic Diseases, 353–361. *Academic Press*. https://doi.org/10.1016/B978-0-12-809286-6.00014-5.

Kumar, M., Barbhai, M. D., Hasan, M., Punia, S., Dhumal, S., Radha, Rais, N., Chandran, D., Pandiselvam, R., Kothakota, A., Tomar, M., Satankar, V., Senapathy, M., Anitha, T., Dey, A., Sayed, A. A. S., Gadallah, F. M., Amarowicz, R. & Mekhemar, M. (2022). Onion (*Allium cepa* L.) peels: A review on bioactive compounds and biomedical activities. *Biomedicine & Pharmacotherapy*, *146*, 112498. https://doi.org/10.1016/J.BIOPHA.2021.112498.

Lola-Luz, T., Hennequart, F. & Gaffney, M. (2014). Effect on health promoting phytochemicals following seaweed application, in potato and onion crops grown under a low input agricultural system. *Scientia Horticulturae*, *170*, 224–227. https://doi.org/10.1016/J.SCIENTA.2014.03.022.

Mardani, N., Jahadi, M., Sadeghian, M., Keighobadi, K. & Khosravi-Darani, K. (2023). Antimicrobial activities, phenolic and flavonoid contents, antioxidant and DNA protection of the internal and outer layers of *Allium cepa* L. from Iran. *NFS Journal*, *31*, 93–101. https://doi.org/10.1016/J.NFS.2023.03.003.

Mila, F. A., Nahar, A., Amin, M. R., Culas, R. J. & Ahmed, A. (2022). Empirical assessment of onion supply chain constraints in Bangladesh: A pre-covid to covid situation. *Journal of Agriculture and Food Research*, *10*, 100418. https://doi.org/10.1016/J.JAFR.2022.100418.

Moglia, M., Cook, S. & Tapsuwan, S. (2018). Promoting water conservation: where to from here? *Water*, *10*(11), 1510.

Norton, G. W. & Alwang, J. (2020). Changes in agricultural extension and implications for farmer adoption of new practices. *Applied Economic Perspectives and Policy*, *42*(1), 8–20.

Pallant, J. (2020). SPSS survival manual: A step by step guide to data analysis using IBM SPSS. McGraw-hill education (UK).

Peters, R. (2018). Seed production in onions and some other *Allium* species. In: *Onions and allied crops*, *CRC Press,* 161–176.

Pratiwi, D. E., Setiawan, B., Puspo, C. & Hardana, A. E. (2019). Measurement model for supply chain performance of Shallot. *IOP Conference Series: Earth and Environmental Science*,

334(1), 12069.

Raimondi, G., Maucieri, C., Squartini, A., Stevanato, P., Tolomio, M., Toffanin, A. & Borin, M. (2023). Soil indicators for comparing medium-term organic and conventional agricultural systems. *European Journal of Agronomy*, *142*, 126669. https://doi.org/10.1016/J.EJA.2022.126669.

Ridolfi, C., Hoffman, V. & Baral, S. (2018). Post-harvest losses: Global scale, solutions, and relevance to Ghana. Intl Food Policy Res Inst., 1-15. Dutch Ministry of Foreign Affairs. Netherland.

Rosliani, R., Hidayat, I. M., Sulastrini, I. & Hilman, Y. (2015). Dissemination of technology for shallot (*Allium ascalonicum* L.) seed production using true shallot seed (TSS) in Indonesia. VII International Symposium on Edible Alliaceae*, 1143*, 345–352.

Saeed, N., Nam, H., Haq, M. I. U. & Muhammad Saqib, D. B. (2018). A survey on multidimensional scaling. *ACM Computing Surveys (CSUR)*, *51*(3), 1-25.

Sang, X., Luo, X., Razzaq, A., Huang, Y. & Erfanian, S. (2023). Can agricultural mechanization services narrow the income gap in rural China? *Heliyon*, *9*(2), e13367. https://doi.org/10.1016/J.HELIYON.2023.E13367.

Sukasih, E. & Musadad, D. (2018). Physico-chemical characteristics of shallot New-Superior Varieties (NSV) from Indonesia. *IOP Conference Series: Earth and Environmental Science*, *102*(1), 12037.

Sule, B. A. (2019). Curbing Post Harvest Losses: The plight of onion farmers in Nigeria.- Food Security Policy Research Brief 89, East Lansing: Michigan State University.

Svetlana, P., Irena, J. & Žaklina, S. (2018). The importance of bank credits for agricultural financing in Serbia. *Ekonomika poljoprivrede*, *65*(1), 65–80. http://dx.doi.org/10.5937/ekoPolj1801065P.

Volaire, F. (2018). A unified framework of plant adaptive strategies to drought: crossing scales and disciplines. *Global Change Biology*, *24*(7), 2929–2938.

Wang, P., Zhang, W., Li, M. & Han, Y. (2019). Does fertilizer education program increase the technical efficiency of chemical fertilizer use? Evidence from wheat production in China. *Sustainability*, *11*(2), 543.

Wicaksono, M. G. S., Suryani, E. & Hendrawan, R. A. (2022). Increasing productivity of rice plants based on IoT (Internet Of Things) to realize Smart Agriculture using System Thinking approach. *Procedia Computer Science*, *197*, 607–616. https://doi.org/10.1016/J.PROCS.2021.12.179.

Xie, D. F., Yu, Y., Wen, J., Huang, J., Chen, J. P., Li, J., Zhou, S. D. & He, X. J. (2020). Phylogeny and highland adaptation of Chinese species in Allium section Daghestanica (Amaryllidaceae) revealed by transcriptome sequencing. *Molecular Phylogenetics and Evolution*, *146*. https://doi.org/10.1016/j.ympev.2020.106737.

Yeshiwas, Y., Alemayehu, M. & Adgo, E. (2023). The rise and fall of onion production; its multiple constraints on pre-harvest and post-harvest management issues along the supply chain in northwest Ethiopia. *Heliyon*, *9*(5), e15905. https://doi.org/10.1016/J.HELIYON.2023.E15905.

Yorobe, J. M., Rejesus, R. M. & Hammig, M. D. (2011). Insecticide use impacts of Integrated Pest Management (IPM) farmer field schools: Evidence from onion farmers in the Philippines. *Agricultural Systems*, *104*(7), 580–587. https://doi.org/10.1016/J.AGSY.2011.05.001.

Zheng, W., Zeng, S., Bais, H., LaManna, J. M., Hussey, D. S., Jacobson, D. L. & Jin, Y. (2018). Plant growth-promoting rhizobacteria (PGPR) reduce evaporation and increase soil water retention. *Water Resources Research*, *54*(5), 3673–3687.

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