DAFTAR PUSTAKA

Agnew, J., Livingstone, D.N., 2011. The SAGE handbook of geographical knowledge. SAGE Handb. Geogr. Knowl. 1–636. https://doi.org/10.4135/9781446201091

Akpo, E., Crane, T.A., Vissoh, P. V., Tossou, R.C., 2015. Co-production of Knowledge in Multi-stakeholder Processes: Analyzing Joint Experimentation as Social Learning. J. Agric. Educ. Ext. 21, 369–388. https://doi.org/10.1080/1389224X.2014.939201

Aksoy, Z., Öz, Ö., 2020. Protection of traditional agricultural knowledge and rethinking agricultural research from farmers ' perspective : A case from Turkey. J. Rural Stud. https://doi.org/10.1016/j.jrurstud.2020.09.017

Akyüz, N.C., Theuvsen, L., 2020. The impact of behavioral drivers on adoption of sustainable agricultural practices: The case of organic farming in Turkey. Sustain. 12.https://doi.org/10.3390/SU12176875

Anderson, S., Fast, J., Keating, N., Eales, J., Chivers, S., Barnet, D., 2017. Translating Knowledge: Promoting Health Through Intergenerational Community Arts Programming. Health Promot. Pract. 18, 15–25. https://doi.org/10.1177/1524839915625037

Ben Arfi, W., Hikkerova, L., Sahut, J.M., 2018. External knowledge sources, green innovation and performance. Technol. Forecast. Soc. Change 129, 210–220. https://doi.org/10.1016/j.techfore.2017.09.017

Bertolozzi-Caredio, D., Bardaji, I., Coopmans, I., Soriano, B., Garrido, A., 2020. Key stepsand dynamics of family farm succession in marginal extensive livestock farming. J. Rural Stud. 76, 131–141. https://doi.org/10.1016/j.jrurstud.2020.04.030

Bohren, M.A., Vogel, J.P., Tunçalp, Ö., Fawole, B., Titiloye, M.A., Olutayo, A.O., Oyeniran,A.A., Ogunlade, M., Metiboba, L., Osunsan, O.R., Idris, H.A., Alu, F.E., Oladapo, O.T., Gülmezoglu, A.M., Hindin, M.J., 2016. "By slapping their laps, the patient will know that you truly care for her": A qualitative study on social norms and acceptabilityof the mistreatment of women during childbirth in Abuja, Nigeria. SSM - Popul. Heal. 2, 640–655. https://doi.org/10.1016/j.ssmph.2016.07.003

BPS Gorontalo Province, 2020. Gorontalo Province in Figures 2020.

Bunders, B.R. and J., Hedges, T. from D. by M., 2009. Knowledge co-creation : Interactionbetween science and society.

Cécile Cochetel33, Kassirin Phiboon234, N.F., 2019. Young farmers in Thailand: small numbers, but diversified projects.

Chambers, R., Conway, G.R., 1992. Sustainable rural livelihoods: practical concepts for the 21st century. IDS Discuss. Pap. 296.

Chaya, W., Gheewala, S.H., 2022. Sustainable livelihood outcomes, causal mechanisms and indicators self-determined by Thai farmers producing bioethanol feedstocks. Sustain. Prod. Consum. 29, 447–466. https://doi.org/10.1016/j.spc.2021.10.030

Chutia, J., Borah, S.P., 2012. Water Stress Effects on Leaf Growth and Chlorophyll

Content but Not the Grain Yield in Traditional Rice (<i>Oryza sativa</i> Linn.) Genotypes of Assam, India II. Protein and Proline Status in Seedlings under PEG Induced Water Stress. Am. J. Plant Sci. 03, 971–980. https://doi.org/10.4236/ajps.2012.37115

Clark, L., 2010. Seeing the social capital in agricultural innovation systems: using

SNA tovisualise bonding and bridging ties in rural communities. Knowl. Manag. Dev. J. 6, 206–218. https://doi.org/10.1080/19474199.2011.554324
Cofré-Bravo, G., Klerkx, L., Engler, A., 2019. Combinations of bonding, bridging, and linking social capital for farm innovation: How farmers configure different support networks. J. Rural Stud. 69, 53–64. https://doi.org/10.1016/j.jrurstud.2019.04.004
Coggan, A., Carwardine, J., Fielke, S., Whitten, S., 2021. Co-creating knowledge in environmental policy development . An analysis of knowledge co-creation in the review of the significant residual impact guidelines for environmental offsets in Queensland , Australia. Environ. Challenges 4, 100138. https://doi.org/10.1016/j.envc.2021.100138
Corbin, J.M., Strauss, A., 1990. Grounded theory research: Procedures, canons, and evaluative criteria. Qual. Sociol. 13, 3–21. https://doi.org/10.1007/BF00988593
Cullen, B., Tucker, J., Snyder, K., Lema, Z., Cullen, B., Tucker, J., Snyder, K., Lema, Z., 2014. An analysis of power dynamics within innovation platforms for natural resource management. Innov. Dev. 0, 1–17. https://doi.org/10.1080/2157930X.2014.921274
Curry, G.N., Nake, S., Koczberski, G., Oswald, M., Rafflegeau, S., Lummani, J., Peter, E.,Nailina, R., 2021. Disruptive innovation in agriculture: Socio-cultural factors in technology adoption in the developing world. J. Rural Stud. 88, 422–431. https://doi.org/10.1016/j.jrurstud.2021.07.022
Djoumessi, Y.F., 2021. What innovations impact agricultural productivity in Sub-Saharan Africa? J. Agric. Food Res. 6, 100228. https://doi.org/10.1016/j.jafr.2021.100228
Dolinska, A., d'Aquino, P., 2016. Farmers as agents in innovation systems. Empowering farmers for innovation through communities of practice. Agric. Syst. 142, 122–130. https://doi.org/10.1016/j.agsy.2015.11.009
Dost, M., Badir, Y.F., Sambasivan, M., Umrani, W.A., 2020. Open-and-closed process innovation generation and adoption: Analyzing the effects of sources of knowledge. Technol. Soc. 62, 101309. https://doi.org/10.1016/j.techsoc.2020.101309
Douthwaite, B., Keatinge, J.D.H., Park, J.R., 2001. Why promising technologies fail: The neglected role of user innovation during adoption. Res. Policy 30, 819–836. https://doi.org/10.1016/S0048-7333(00)00124-4
Drucker, P.F., 1993. The rise of the knowledge societyThe Wilson Quarterly, vol. 17, no. 2, 1993, p. 52+. Accessed 16 Feb. 2021.
Ellis, F., 2000. The determinants of rural livelihood diversification in developing countries.J. Agric. Econ. 51, 289–302. https://doi.org/10.1111/j.1477-9552.2000.tb01229.x
Ellis, F., Allison, E., 2004. Access to Natural Resources Sub-Programme Livelihoods
Diversification and Enterprise Development Sub-programme Livelihood diversification and natural resource access Livelihood Support Programme (LSP) Aninter-departmental programme for improving support. Livelihood Support Program. Work. Pap. 9 9, 1–79.
Fatchiya, A., Amanah, S., Kusumastuti, Y.I., 2016. Penerapan Inovasi Teknologi Pertanian dan Hubungannya dengan Ketahanan Pangan Rumah Tangga Petani. J. Penyul. 12, 190. https://doi.org/10.25015/penyuluhan.v12i2.12988
Fernando, S., Garnevska, E., Ramilan, T., Shadbolt, N., 2021. Organisational attributes ofcooperatives and farmer companies. J. Co-op. Organ. Manag. 9, 100132. https://doi.org/10.1016/j.jcom.2021.100132

Florida, R., 2017. The economic geography of talent. Econ. Crit. Essays Hum. Geogr. 305–317. https://doi.org/10.4324/9781351159203-14
Garforth, C., Angell, B., Archer, J., Green, K., 2003. Improving Farmers' Access to Advice on Land Management: Lessons from Case Studies in Developed Countries. Agric. Ext. Netw. 1–24.
Gava, O., Favilli, E., Bartolini, F., Brunori, G., 2017. Knowledge networks and their role inshaping the relations within the Agricultural Knowledge and Innovation System in theagroenergy sector. The case of biogas in Tuscany (Italy). J. Rural Stud. 56, 100–113.https://doi.org/10.1016/j.jrurstud.2017.09.009
Gielen, P.M., Hoeve, A., Nieuwenhuis, L.F.M., 2003. Learning Entrepreneurs: Learning and Innovation in Small Companies. Eur. Educ. Res. J. 2, 90–106. https://doi.org/10.2304/eerj.2003.2.1.13
Hailemicheal, A., Gebremedhin, B., Gizaw, S., Tegegne, A., 2016. Analysis of village poultry value chain in Ethiopia : Implications for action research and development. LIVES Work. Pap. 10, 1–44.
Harrison, J., 2006. Financial Management and Dairy Farmer Satisfaction with Performance. Int. J. Agric. Manag. 3, 1.
Herrmann-Pillath, C., 2020. The art of co-creation: An intervention in the philosophy ofecologicaleconomics. Ecol. Econ. 169. https://doi.org/10.1016/j.ecolecon.2019.106526
Hilkens, A., Reid, J.I., Klerkx, L., Gray, D.I., 2018. Money talk: How relations between farmers and advisors around financial management are shaped. J. Rural Stud. 63, 83–95. https://doi.org/10.1016/j.jrurstud.2018.09.002
Huang, C., 2019. Cocreating social innovations between an agro-food company and rice farmers in Taiwan : exploring the process mechanisms. https://doi.org/10.1108/BFJ- 10-2019-0759
Idham, I., Pagiu, S., Lasmini, S.A., Nasir, B.H., 2021. Effect of doses of green manure from different sources on growth and yield of maize in Dryland. Int. J. Des. Nat. Ecodynamics 16, 61–67. https://doi.org/10.18280/ijdne.160108
Ingram, J., 2010. Technical and social dimensions of farmer learning: An analysis of the emergence of reduced tillage systems in england. J. Sustain. Agric. 34, 183–201. https://doi.org/10.1080/10440040903482589
Jabal, Z.K., Khayyun, T.S., Alwan, I.A., 2022. Impact of Climate Change on Crops Productivity Using MODIS-NDVI Time Series. Civ. Eng. J. 8, 1136–1156. https://doi.org/10.28991/CEJ-2022-08-06-04
Jaganathan, D., Methodologies, D., 2020. Participatory approaches for enhancing technology utilization in coconut in Indian Coconut Journal.
James, M.N., Josephine, M., 2022. TECHNOLOGICAL INNOVATION ON SUCCESS OFCOCONUT SMALL AND.
Jamil, I., Jun, W., Mughal, B., Wheed, J., Hussain, H., Waseem, M., 2021. Agricultural Innovation: A comparative analysis of economic benefits gained by farmers under climate resilient and conventional agricultural practices. Land use policy 108, 105581. https://doi.org/10.1016/j.landusepol.2021.105581
Jongbloed, B., Enders, J., Salerno, C., 2008. Higher education and its communities: Interconnections, interdependencies and a research agenda. High. Educ. 56, 303– 324. https://doi.org/10.1007/s10734-008-9128-2
Junais, I., Samsuar, Daniel, Ali, H.M., Yusran, Syarif, A., Mansyur, M.H., 2020. Young farmers and parents' perception for the future of agriculture: Socio-spatial integrationof Coffee Farmers in Jeneponto Regency. IOP Conf. Ser. Earth Environ. Sci. 473. https://doi.org/10.1088/1755-1315/473/1/012017
Kailanya, M.D., 2014. The effect of financial literacy on financial returns of miraa

farmers in Meru county 1–80.
Kasurinen, J., 2012. Software Organizations and Test Process Development, Advances in Computers. Elsevier Inc. https://doi.org/10.1016/B978-0-12-396526-4.00001-1
Keban, A., Lalus, M.F., Sogen, J.G., 2019. Strategy for Increasing Farmers' Income Through Dry Land Resources Combination in Kupang District of Nusa Tenggara Timur. Russ. J. Agric. Socio-Economic Sci. 91, 349–357. https://doi.org/10.18551/rjoas.2019-07.41
Klerkx, L., Adjei-Nsiah, S., Adu-Acheampong, R., Saïdou, A., Zannou, E., Soumano, L., Sakyi-Dawson, O., van Paassen, A., Nederlof, S., 2013. Looking at agricultural innovation platforms through an innovation champion lens: An analysis of three casesin West Africa. Outlook Agric. 42, 185–192. https://doi.org/10.5367/oa.2013.0137
Klerkx, L., Schut, M., Leeuwis, C., Kilelu, C., 2012. Advances in knowledge brokering in the agricultural sector: Towards innovation system facilitation. IDS Bull. 43, 53–60. https://doi.org/10.1111/j.1759-5436.2012.00363.x
Laforge, J.M.L., McLachlan, S.M., 2018. Learning communities and new farmer knowledge in Canada. Geoforum 96, 256–267. https://doi.org/10.1016/j.geoforum.2018.07.022
Liu, T., Bruins, R.J.F., Heberling, M.T., 2018. Factors influencing farmers' adoption of bestmanagement practices: A review and synthesis. Sustain. 10, 1–26. https://doi.org/10.3390/su10020432
Loison, S.A., To, 2015. Rural Livelihood Diversification in Sub-Saharan Africa: A LiteratureReview. J. Dev. Stud. 51, 1125–1138. https://doi.org/10.1080/00220388.2015.1046445
Lwoga, E.T., Ngulube, P., Stilwell, C., 2010. Managing indigenous knowledge for sustainable agricultural development in developing countries: Knowledge management approaches in the social context. Int. Inf. Libr. Rev. 42, 174–185. https://doi.org/10.1016/j.iilr.2010.07.006
Maninggar, N., 2019. Accelerating Economic Development through Technopark: The staging of National Science-Technopark Formation Process in Indonesia. IOP Conf. Ser. Earth Environ. Sci. 328. https://doi.org/10.1088/1755-1315/328/1/012047
Mc Fadden, T., 2016. A description of data sets to determine the innovative diversification capacity of farm households. Data Br. 8, 1088–1093. https://doi.org/10.1016/j.dib.2016.07.007
Mcclintock, N.C., 2006. Regenerative agricultural entrepreneurship and education along the Petite Côte , Senegal. Leisa Mag. 26–27.
Miles and Huberman, 1999. Qualitative Data Analysis An expanded Sourcebook 2nd Edition by Matthew B. Miles, Michael Huberman (z-lib.org).pdf.
Mills, J., Reed, M., Skaalsveen, K., Ingram, J., 2019. The use of Twitter for knowledge exchange on sustainable soil management. Soil Use Manag. 35, 195–203. https://doi.org/10.1111/sum.12485
Milone, P., Ventura, F., 2019. New generation farmers: Rediscovering the peasantry. J. Rural Stud. 65, 43–52. https://doi.org/10.1016/j.jrurstud.2018.12.009
Minah, M., 2022. What is the influence of government programs on farmer organizations and their impacts? Evidence from Zambia. Ann. Public Coop. Econ. 93, 29–53. https://doi.org/10.1111/apce.12316
Ming-yue, L.I.U., Xiao-long, F., San-gui, W., Yu, Z., 2021. Does poverty-alleviation-basedindustry development improve farmers ' livelihood capital ? J. Integr. Agric. 20, 915– 926. https://doi.org/10.1016/S2095-3119(20)63449-9

Mónica Edwards-Schachter, M.L.W., 2017. ' Shaken , but not stirred ': Sixty years of defining social innovation. Technol. Forecast. Soc. Chang.
Musyoki, M.E., Busienei, J.R., Gathiaka, J.K., Karuku, G.N., 2022. Linking farmers' risk attitudes, livelihood diversification and adoption of climate smart agriculture technologies in the Nyando basin, South-Western Kenya. Heliyon 8, e09305. https://doi.org/10.1016/j.heliyon.2022.e09305
Mutsvangwa-Sammie, E.P., Manzungu, E., 2021. Unpacking the narrative of agricultural innovations as the sine qua non of sustainable rural livelihoods in Southern Africa. J. Rural Stud. 86, 181–188. https://doi.org/10.1016/j.jrurstud.2021.06.005
Mwangi, M., Kariuki, S., 2015. Factors Determining Adoption of New Agricultural Technology by Smallholder Farmers in Developing Countries. Issn 6, 2222–1700.
Mwangi, M., Kituyi, E., Ouma, G., 2020. Enhancing adoption of climate services through an innovation systems approach. Sci. African 8, e00445. https://doi.org/10.1016/j.sciaf.2020.e00445
Neumeier, S., 2012. Why do Social Innovations in Rural Development Matter and Should They be Considered More Seriously in Rural Development Research ? — Proposal for a Stronger Focus on Social Innovations in Rural Development Research. Sociol. Ruralis 52. https://doi.org/10.1111/j.1467-9523.2011.00553.x
Ngulube, P., Stilwell, C., 2007. nderstanding indigenous knowledge : 12. https://doi.org/10.4102/sajim.v12i1.436
Norström, A. V., Cvitanovic, C., Löf, M.F., West, S., Wyborn, C., Balvanera, P., Bednarek,A.T., Bennett, E.M., Biggs, R., de Bremond, A., Campbell, B.M., Canadell, J.G., Carpenter, S.R., Folke, C., Fulton, E.A., Gaffney, O., Gelcich, S., Jouffray, J.B., Leach, M., Le Tissier, M., Martín-López, B., Louder, E., Loutre, M.F., Meadow, A.M., Nagendra, H., Payne, D., Peterson, G.D., Reyers, B., Scholes, R., Speranza, C.I., Spierenburg, M., Stafford-Smith, M., Tengö, M., van der Hel, S., van Putten, I., Österblom, H., 2020. Principles for knowledge co-production in sustainability research. Nat. Sustain. 3, 182–190. https://doi.org/10.1038/s41893-019-0448-2
NSLC, 2018. Komoditas jagung provinsi gorontalo.
NSLIC (2020), n.d. Kajian Ekonomi Komoditas Kelapa Provinsi Gorontalo by. NSLIC Gorontalo, 2018. Kajian Ekonomi Komoditas Kelapa Provinsi Gorontalo.
Aksoy, Z., & Öz, Ö. (2020). Protection of traditional agricultural knowledge and rethinking agricultural research from farmers ' perspective : A case from Turkey. *Journal of Rural Studies*, *September*. https://doi.org/10.1016/j.jrurstud.2020.09.017
Akyüz, N. C., & Theuvsen, L. (2020). The impact of behavioral drivers on adoption of sustainable agricultural practices: The case of organic farming in Turkey. *Sustainability (Switzerland)*, *12*(17). https://doi.org/10.3390/SU12176875
Chambers, R., & Conway, G. R. (1992). Sustainable rural livelihoods: practical concepts for the 21st century. *IDS Discussion Paper*, *296*.
Chaya, W., & Gheewala, S. H. (2022). Sustainable livelihood outcomes, causal mechanisms and indicators self-determined by Thai farmers producing bioethanol feedstocks. *Sustainable Production and Consumption*, *29*, 447–466. https://doi.org/10.1016/j.spc.2021.10.030
Creswell, J. W., & Poth, C. N. (2018). *Creswell, John W* (pp. 1–459).
Curry, G. N., Nake, S., Koczberski, G., Oswald, M., Rafflegeau, S., Lummani, J.,

Peter, E., & Nailina, R. (2021). Disruptive innovation in agriculture: Socio-cultural factors in technology adoption in the developing world. *Journal of Rural Studies*, *88*(December 2020), 422–431. https://doi.org/10.1016/j.jrurstud.2021.07.022

Djoumessi, Y. F. (2021). What innovations impact agricultural productivity in Sub-Saharan Africa? *Journal of Agriculture and Food Research*, *6*, 100228. https://doi.org/10.1016/j.jafr.2021.100228

Ellis, F. (2000). The determinants of rural livelihood diversification in developing countries. *Journal of Agricultural Economics*, *51*(2), 289–302. https://doi.org/10.1111/j.1477-9552.2000.tb01229.x

Fernando, S., Garnevska, E., Ramilan, T., & Shadbolt, N. (2021). Organisational attributes of cooperatives and farmer companies. *Journal of Co-Operative Organization and Management*, *9*(1), 100132. https://doi.org/10.1016/j.jcom.2021.100132

Hailemicheal, A., Gebremedhin, B., Gizaw, S., & Tegegne, A. (2016). Analysis of village poultry value chain in Ethiopia : Implications for action research and development. *LIVES Working Paper*, *10*(March), 1–44. https://cgspace.cgiar.org/handle/10568/71088

Harrison, J. (2006). Financial Management and Dairy Farmer Satisfaction with Performance. *International Journal of Agricultural Management*, *3*(4), 1.

James, M. N., & Josephine, M. (2022). *TECHNOLOGICAL INNOVATION ON SUCCESS OF COCONUT SMALL AND*.

Jamil, I., Jun, W., Mughal, B., Wheed, J., Hussain, H., & Waseem, M. (2021). Agricultural Innovation: A comparative analysis of economic benefits gained by farmers under climate resilient and conventional agricultural practices. *Land Use Policy*, *108*(June), 105581. https://doi.org/10.1016/j.landusepol.2021.105581

Kailanya, M. D. (2014). *The effect of financial literacy on financial returns of miraa farmers in Meru county*. 1–80.

Loison, S. A., & To. (2015). Rural Livelihood Diversification in Sub-Saharan Africa: A Literature Review. *Journal of Development Studies*, *51*(9), 1125–1138. https://doi.org/10.1080/00220388.2015.1046445

Mcclintock, N. C. (2006). Regenerative agricultural entrepreneurship and education along the Petite Côte , Senegal. *Leisa Magazine*, 26–27.

Miles and Huberman. (1999). *Qualitative Data Analysis An expanded Sourcebook 2nd Edition by Matthew B. Miles, Michael Huberman (z-lib.org).pdf* (p. 354).

Minah, M. (2022). What is the influence of government programs on farmer organizations and their impacts? Evidence from Zambia. *Annals of Public and Cooperative Economics*, *93*(1), 29–53. https://doi.org/10.1111/apce.12316

Ming-yue, L. I. U., Xiao-long, F., San-gui, W., & Yu, Z. (2021). Does poverty-alleviation-based industry development improve farmers ' livelihood capital ? *Journal of Integrative Agriculture*, *20*(4), 915–926. https://doi.org/10.1016/S2095-3119(20)63449-9

Musyoki, M. E., Busienei, J. R., Gathiaka, J. K., & Karuku, G. N. (2022). Linking farmers' risk attitudes, livelihood diversification and adoption of climate smart agriculture technologies in the Nyando basin, South-Western Kenya. *Heliyon*, *8*(4), e09305. https://doi.org/10.1016/j.heliyon.2022.e09305

NSLC. (2018). *Komoditas jagung provinsi gorontalo*.

NSLIC Gorontalo. (2018). *Kajian Ekonomi Komoditas Kelapa Provinsi Gorontalo*.

Nurdin, Rauf, A., Rahim, Y., Adam, E., Musa, N., Jamin, F. S., Dude, S., Rahman, R., & Katili, H. A. (2023). Determination of Land Suitability Criteria

for Maize Hybrid in Boalemo Regency Based on Optimum Yield and Selected Land Quality. *Applied and Environmental Soil Science*, *2023*. https://doi.org/10.1155/2023/3800877

Nurdin, Rayes, M. L., Soemarno, & Sudarto. (2020). Study of Land Quality and Land Characteristics that Determine the Productivity of Composite Maize Varieties in Gorontalo. *Systematic Reviews in Pharmacy*, *11*(12), 500–509. https://doi.org/10.31838/srp.2020.12.81

Nurdin, Rayes, M. L., Soemarno, & Sudarto. (2021). Analysis of Quality and Land Characteristics That Control Local Maize Production in Gorontalo. *Proceedings of the International Seminar on Promoting Local Resources for Sustainable Agriculture and Development (ISPLRSAD 2020)*, *13*(Isplrsad 2020), 438–446. https://doi.org/10.2991/absr.k.210609.068

Oladipupo, A. M. (2014). Effect of T&V Innovation on Income and Farmers Performance in Edo State Nigeria. *American Journal of Agriculture and Forestry*, *2*(4), 159. https://doi.org/10.11648/j.ajaf.20140204.19

Pannell, D. J., & Claassen, R. (2020). The Roles of Adoption and Behavior Change in Agricultural Policy. *Applied Economic Perspectives and Policy*, *42*(1), 31–41. https://doi.org/10.1002/aepp.13009

Rustinsyah, R. (2019). The significance of social relations in rural development: A case study of a beef-cattle farmer group in Indonesia. *Journal of Co-Operative Organization and Management*, *7*(2), 100088. https://doi.org/10.1016/j.jcom.2019.100088

Scoones, I. (2009). Livelihoods perspectives and rural development. *Journal of Peasant Studies*, *36*(1), 171–196. https://doi.org/10.1080/03066150902820503

Talerngsri-Teerasuwannajak, K., & Pongkijvorasin, S. (2021). Agricultural business model and upland sustainability: Evidence from northern Thailand. *Current Research in Environmental Sustainability*, *3*, 100085. https://doi.org/10.1016/j.crsust.2021.100085

Tambo, J. A., & Wünscher, T. (2017). Farmer-led innovations and rural household welfare: Evidence from Ghana. *Journal of Rural Studies*, *55*, 263–274. https://doi.org/10.1016/j.jrurstud.2017.08.018

Thulstrup, A. W. (2015). Livelihood Resilience and Adaptive Capacity: Tracing Changes in Household Access to Capital in Central Vietnam. *World Development*, *74*, 352–362. https://doi.org/10.1016/j.worlddev.2015.05.019

Yin K.Robert. (2018). Case study research and applications : design and methods / Robert K. Yin. In *SAGE Publication, Inc* (Sixth Edit). SAGE Publication, Inc.

Oladipupo, A.M., 2014. Effect of T&V Innovation on Income and Farmers Performance inEdo State Nigeria. Am. J. Agric. For. 2, 159. https://doi.org/10.11648/j.ajaf.20140204.19

Padel, S., 2001. Conversion to organic farming: A typical example of the diffusion of an innovation? Sociol. Ruralis 41, 40–61. https://doi.org/10.1111/1467-9523.00169

Pannell, D.J., Claassen, R., 2020. The Roles of Adoption and Behavior Change in Agricultural Policy. Appl. Econ. Perspect. Policy 42, 31–41. https://doi.org/10.1002/aepp.13009

Patel, S.K., Sharma, A., Singh, G.S., 2020. Traditional agricultural practices in India: an approach for environmental sustainability and food security. Energy, Ecol. Environ. 5, 253–271. https://doi.org/10.1007/s40974-020-00158-2

Porlezza, C., Innovation, C., Industries, C., 2012. City Research Online City ,

University of London Institutional Repository 3. https://doi.org/10.1007/s13132-011-0051-x
Powell, W.W., Snellman, K., 2004. The knowledge economy. Annu. Rev. Sociol. 30, 199–220. https://doi.org/10.1146/annurev.soc.29.010202.100037
Qiu, K., 2011. Research of university science and technology innovation system based onlow-carbon economy. EnergyProcedia 5, 1032–1036. https://doi.org/10.1016/j.egypro.2011.03.182
Rajak, A.R.A., 2022. Emerging Technological Methods for Effective Farming by Cloud Computing and IoT. Emerg. Sci. J. 6, 1017–1031. https://doi.org/10.28991/ESJ-2022-06-05-07
Ramirez, A., 2013. The Influence of Social Networks on Agricultural Technology Adoption.Procedia-Soc. Behav. Sci. 79, 101–116. https://doi.org/10.1016/j.sbspro.2013.05.059
Raza, A., Saeed, S., Yousafzai, S., Shahid, M.U., Muffatto, M., 2020. Institutional adversity, external knowledge sources, and new ventures' innovation: An institutionalpolycentrism theory perspective. Ind. Mark. Manag. 90, 633–647. https://doi.org/10.1016/j.indmarman.2020.03.018
Ribot, J.C., Peluso, N.L., 2003. A theory of access. Rural Sociol. 68, 153–181. https://doi.org/10.1111/j.1549-0831.2003.tb00133.x
Ros-tonen, M.A.F., Leynseele, Y. Van, Laven, A., Sunderland, T., 2015. Landscapes of Social Inclusion : Inclusive Value-Chain Collaboration Through the Lenses of Food Sovereignty and Landscape Governance Landscapes of Social Inclusion : Inclusive Value-Chain Collaboration Through the Lenses of Food Sovereignty and Landscape. . https://doi.org/10.1057/ejdr.2015.50
Rustinsyah, R., 2019. The significance of social relations in rural development: A case study of a beef-cattle farmer group in Indonesia. J. Co-op. Organ. Manag. 7, 100088.https://doi.org/10.1016/j.jcom.2019.100088
Salman, D., Kasim, K., Ahmad, A., Sirimorok, N., 2021. Combination of bonding, bridging and linking social capital in a livelihood system: Nomadic duck herders amid the covid-19 pandemic in South Sulawesi, Indonesia. For. Soc. 5, 136–158. https://doi.org/10.24259/fs.v5i1.11813
Schneider, F., Steiger, D., Ledermann, T., Fry, P., Rist, S., 2012. No-tillage farming: Co- creation of innovation through network building. L. Degrad. Dev. 23, 242–255. https://doi.org/10.1002/ldr.1073
Scoones, I., 2009. Livelihoods perspectives and rural development. J. Peasant Stud. 36, 171–196. https://doi.org/10.1080/03066150902820503
Skaalsveen, K., Ingram, J., Urquhart, J., 2020. The role of farmers' social networks in the implementation of no-till farming practices. Agric. Syst. 181. https://doi.org/10.1016/j.agsy.2020.102824
Spielman, D.J., Davis, K., Negash, M., Ayele, G., 2011. Rural innovation systems and networks: Findings from a study of Ethiopian smallholders. Agric. Human Values 28,195–212. https://doi.org/10.1007/s10460-010-9273-y
Struik, P.C., Klerkx, L., van Huis, A., Röling, N.G., 2014. Institutional change towards sustainable agriculture in West Africa. Int. J. Agric. Sustain. 12, 203–213. https://doi.org/10.1080/14735903.2014.909641
Šūmane, S., Kunda, I., Knickel, K., Strauss, A., Tisenkopfs, T., Rios, I. des I., Rivera, M., Chebach, T., Ashkenazy, A., 2018. Local and farmers' knowledge matters! How integrating informal and formal knowledge enhances sustainable and resilient agriculture. J. Rural Stud. 59, 232–241. https://doi.org/10.1016/j.jrurstud.2017.01.020
Sumarno, J., Hiola, F.S.I., 2017. Faktor Sosial Ekonomi Yang Mempengaruhi

Adopsi Pengelolaan Tanaman Terpadu (Ptt) Jagung Di Gorontalo. Inform. Pertan. 26, 99. https://doi.org/10.21082/ip.v26n2.2017.p99-110
Talerngsri-Teerasuwannajak, K., Pongkijvorasin, S., 2021. Agricultural business model and upland sustainability: Evidence from northern Thailand. Curr. Res. Environ. Sustain. 3, 100085. https://doi.org/10.1016/j.crsust.2021.100085
Tambo, J.A., Wünscher, T., 2017. Farmer-led innovations and rural household welfare: Evidence from Ghana. J. Rural Stud. 55, 263–274. https://doi.org/10.1016/j.jrurstud.2017.08.018
Thomas, E., Riley, M., Spees, J., 2020. Knowledge flows: Farmers' social relations and knowledge sharing practices in 'Catchment Sensitive Farming.' Land use policy 90. https://doi.org/10.1016/j.landusepol.2019.104254
Thu Trang, N.T., Loc, H.H., 2021. Livelihood sustainability of rural households in adapting to environmental changes: An empirical analysis of ecological shrimp aquaculture model in the Vietnamese Mekong Delta. Environ. Dev. 39, 100653. https://doi.org/10.1016/j.envdev.2021.100653
Thulstrup, A.W., 2015. Livelihood Resilience and Adaptive Capacity: Tracing Changes in Household Access to Capital in Central Vietnam. World Dev. 74, 352–362. https://doi.org/10.1016/j.worlddev.2015.05.019
Tolinggi, W.K., Gubali, H., Baruwadi, M., 2018. Potency Analysis for Agro Science Development Plan in Gorontalo Province Techno Park 6, 13–25. https://doi.org/10.20956/ijas.v6i1.1281
Triste, L., Debruyne, L., Vandenabeele, J., Marchand, F., Lauwers, L., 2018. Communities of practice for knowledge co-creation on sustainable dairy farming: features for value creation for farmers. Sustain. Sci. 13, 1427–1442. https://doi.org/10.1007/s11625- 018-0554-5
Tsouvalis, J., Seymour, S., Watkins, C., 2000. Exploring knowledge-cultures : precision farming , yield mapping , and the expert ^ farmer interface 32, 909–924. https://doi.org/10.1068/a32138
Turner, J.A., Horita, A., Fielke, S., Klerkx, L., Blackett, P., Bewsell, D., Small, B., Boyce, W.M., 2020. Revealing power dynamics and staging conflicts in agricultural system transitions: Case studies of innovation platforms in New Zealand. J. Rural Stud. 76, 152–162. https://doi.org/10.1016/j.jrurstud.2020.04.022
van der Ploeg, J.D., 2018. The New Peasantries Rural Development in Times of Globalization, Second Edi. ed. Routledge, New York, NY 10017.
Van Der Valk, T., Gijsbers, G., 2010. The use of social network analysis in innovation studies: Mapping actors and technologies. Innov. Manag. Policy Pract. 12, 5–17. https://doi.org/10.5172/impp.12.1.5
van Ewijk, E., Ros-Tonen, M.A.F., 2021. The fruits of knowledge co-creation in agricultureand food-related multi-stakeholdervan Ewijk, E., & Ros-Tonen, M. A. F. (2021). The fruits of knowledge co-creation in agriculture and food-related multi-stakeholder platforms in sub-Saharan Africa — A sys. Agric. Syst. 186, 102949. https://doi.org/10.1016/j.agsy.2020.102949
Van Rijn, F., Bulte, E., Adekunle, A., 2012. Social capital and agricultural innovation in Sub-Saharan Africa. Agric. Syst. 108, 112–122. https://doi.org/10.1016/j.agsy.2011.12.003
Veselá, D., Klimová, K., 2014. Knowledge-based Economy vs. Creative Economy. Procedia-Soc. Behav. Sci. 141, 413–417. https://doi.org/10.1016/j.sbspro.2014.05.072
Vishnu, S., Gupta, J., Subash, S.P., 2019. Social network structures among the livestock farmers vis a vis calcium supplement technology. Inf. Process.

Agric. 6, 170–182. https://doi.org/10.1016/j.inpa.2018.07.006
Voorberg, W.H., Bekkers, V.J.J.M., Tummers, L.G., 2015. A Systematic Review of Co- Creation and Co-Production: Embarking on the social innovation journey. Public Manag. Rev. 17, 1333–1357. https://doi.org/10.1080/14719037.2014.930505
Walsh, P.P., Murphy, E., Horan, D., 2020. The role of science, technology and innovationin the UN 2030 agenda. Technol. Forecast. Soc. Change 154, 119957. https://doi.org/10.1016/j.techfore.2020.119957
Wayangkau, I.H., Mekiuw, Y., Rachmat, R., Suwarjono, S., Hariyanto, H., 2020. Utilizationof IoT for soil moisture and temperature monitoring system for onion growth. Emerg.Sci. J. 4, 102–115. https://doi.org/10.28991/ESJ-2021-SP1-07
Wójcik, M., Jeziorska-Biel, P., Czapiewski, K., 2019. Between words: A generational discussion about farming knowledge sources. J. Rural Stud. 67, 130–141. https://doi.org/10.1016/j.jrurstud.2019.02.024
Wong, C.Y., Goh, K.L., 2012. The sustainability of functionality development of science and technology: Papers and patents of emerging economies. J. Informetr. 6, 55–65. https://doi.org/10.1016/j.joi.2011.07.001
Wood, B.A., Blair, H.T., Gray, D.I., Kemp, P.D., Kenyon, P.R., Morris, S.T., Sewell, A.M., 2014. Agricultural science in the wild: A social network analysis of farmer knowledge exchange. PLoS One 9. https://doi.org/10.1371/journal.pone.0105203
Wyborn, C., 2015. Co-productive governance: A relational framework for adaptive governance. Glob. Environ. Chang.30, 56–67. https://doi.org/10.1016/j.gloenvcha.2014.10.009
Xiao-Yuan, L.I.U., 2021. Agricultural products intelligent marketing technology innovation in big data era. Procedia Comput. Sci. 183, 648–654. https://doi.org/10.1016/j.procs.2021.02.110
Yin K.Robert, 2018. Case study research and applications : design and methods / Robert K. Yin, Sixth Edit. ed, SAGE Publication, Inc. SAGE Publication, Inc, United Kingdom.
Zhang, Y., Zhang, M., Luo, N., Wang, Y., Niu, T., 2019. Understanding the formation mechanism of high-quality knowledge in social question and answer communities: A knowledge co-creation perspective. Int. J. Inf. Manage. 48, 72–84. https://doi.org/10.1016/j.ijinfomgt.2019.01.022

LAMPIRAN

Lampiran Topik 1. Karakteristik informan Penelitian

Karakeristik Sosial Ekonomi Petani Jagung Informan Penelitian									Durasi wawancara (menit)
No/inisial Petani	Kategori Generasi Petani		Luas Lahan (hektar)	Tingkat Pendidikan	Pengalaman Bertani /olahan (tahun)	Kategori Aktivitas			
	Muda 20-45 tahun	Tua 46-65 tahun				Budidaya	Pengolahan	Tujuan Pemasaran	
1. YP	42	60	2	SD	30	Jagung dan kelapa	Jagung pipil	Pedagang pengumpul	75
2. AH	-	50	10	SMP	15	Jagung dan kelapa	Jagung pipil	Pabrik	30
3. OP	-	51	1	SMP	19	Jagung	Jagung pipil	Pabrik	35
4. AM	-	48	3	SMA	7	Jagung	Jagung pipil	Pabrik	30
5. MG	44	-	2	SMP	11	Jagung	Jagung pipil	Pabrik	25
6. AW	43	-	10	SMA	25	Jagung	Jagung pipil	Pabrik luar daerah	65
7. YL		70	4	SD	22	Jagung	Jagung pipil	Pabrik	35
8. MP	45	-	1	SMA	10	jagung	Stick Jagung	Supermarket	20
9. JF	44	-	2	SMA	12	Jagung	Pia jagung, tepung jagung	Supermarket, pasar luar daerah	60
10.MD	29	-	1	Sarjana	5	Jagung	Pia jagung, stick jagung	Warung, Supermarket	45
11.YL	-	70	4	SD	22	Jagung dan kelapa	Jagung pipil	Pedagang pengumpul	30
12.UH	-	60	2	SD	30	Jagung	Jagung pipil	pedagang pengumpul	25
13.SM	-	69	1	SMP	38	Jagung	Jagung pipil	Pabrik, pedagang pengumpul	30
14. YH	-	59	2	SMP	29	Jagung	Jagung pipil	Pedagang Pengumpul	30
15.AW	43	-	10	SMA	25	Jagung	Jagung pipil, pakan ternak	Pasar luar daerah	65
16.SM	-	69	1	SD	38	Jagung dan kelapa	Jagung pipilan	Pedagang Pengumpul	30
17.YH	-	59	2	SD	19	Jagung	Jagung pipilan	pedagang pengumpul	30
18.AK	-	54	2	SMP	21	Jagung	Jagung pipilan	Pabrik, pedagang pengumpul	35
19.SD	39	-	5	Sarjana	12	Jagung dan kelapa	Jagung pipilan	Pabrik	25
20.MA	-	55	5	SMA	20	kelapa	Kopra, penangkar bibt, buah segar	Pabrik, pedagang pengumpul, petani	30
21.AR	-	52	2	SD	30	Jagung dan Kelapa	Jagung pipilan	pedagang pengumpul	30
22.YH	-	59	30	SMP	29	Jagung dan Kelapa	Jagung Pipilan	pedagang pengumpul	25
23.RD	43	-	1	SMA	9	Jagung	Bepang Jagung	Pasarl	45
24.NH	29	-	1	Sarjana	15	Kelapa, jagung		Pabrik, pedagang pengumpul	45
25.SL	42	-	8	SMA	44	Jagung	Jagung pipilan	Pabrik luar daerah	30
26.SA	42	-	3	Sarjana	20	Kelapa, jagung	Jagung Pipilan	Pabrik	75
27.DB	44	-	1	SMA	11	Jagung	Tepung dan Pia jagung	Pabrik, Pasarlokal dan luar daerah	40
28.LD	42	-	2	SMA	8	jagung jagung	Jagung Pipilan	Pabrik	75

Karakeristik Sosial Ekonomi Petani Jagung Informan Penelitian									Durasi wawancara (menit)
No/inisial Petani	Kategori Generasi Petani		Luas Lahan (hektar)	Tingkat Pendidikan	Pengalaman Bertani /olahan (tahun)	Kategori Aktivitas			
	Muda 20-45 tahun	Tua 46-65 tahun				Budidaya	Pengolahan	Tujuan Pemasaran	
29. RML	40	-	2	SMA	10	Jagung, hortikultura	Jagung Pipilan	Pabrik	75

Lampiran Topik 2. Konsep Kuesioner

JUDUL PENELITIAN : Regenerasi Petani dan Knowledge co-creation dalam Keberlanjutan Usaha Tani Kelapa di Gorontalo, Indonesia

Karakteristik Sosial Ekonomi Informan

Umur	: ……
Pendidikan Formal	: ……
Pendidikan Non Formal	: ……
Pengalaman Bertani (tahun)	: ……
Pendapatan (hektar/musim tanam)	: ……
Luasa Lahan (hektar)	: ……
Status Pemilikan Lahan	: Pemilik / Penggarap
Aktor Utama Sumber Pengetahuan	: 1. Keluarga 2. Teman 3. Ketua Kelompok Tani 4. Pengurus Klp.Tani

A. Orientasi Tindakan Petani tua dan Petani Muda

1. Bagaimana cara, teknik bapak/ibu dalam melakukan budidaya, pengolahan dan pemasaran usaha tani kelapa ?
2. Siapa saja sumber-sumber pengetahuan dalam budidaya kelapa, pengolahan dan pemasaran usaha tani kelapa?
3. Apakah ada penggunaan teknologi dalam budidaya, pengolahan dan pemasaran usahatani kelapa? Sebutkan teknologi apa saja?
4. Apakah ada alat, cara dan metode pengetahuan dalam budidaya, pengolahan dan pemasaran usaha tani kelapa?
5. Apakah motivasi petani dalam mengadopsi penggunaan teknologi budidaya, pengolahan dan pemasaran usahatani kelapa?
6. Apa perubahan pengetahuan dan teknologi pada aspek budidaya, pengolahan dan pemasaran)

7. Apakah petani pernah mendapatkan pelatihan teknologi baru? Pelatihan apa dan dari lembaga mana?
8. Apakah ada jaringan atau koneksi dengan lembaga lain untuk mendapatkan inovasi teknologi?
9. Apakah pernah melakukan konsultasi layanan teknologi dan inovasi pertanian pada saat mendaptkan masalah dalam usaha tani kelapa?
10. Apakah ada interaksi/komunkasi dalam usaha tani dalam keluarga?
11. Siapa saja dalam keluarga yang paling dominan diajak komunikasi untuk berbagi pengetahuan dan teknologi pertanian? Komunikasi apa saja?

B. *Knowledge co-creation* Petani Tua dan Petani Muda

1. Pengetahuan dan teknologi apa saja yang disampaikan ke petani sebaya, petani lebih tua dan petani lebih muda?
2. Apasaja metode,alat dan cara pengetahuan dan teknologi yang disampaikan dari petani sebaya, petani lebih tua dan petani lebih muda?
3. Bagaimana respon atau tanggapan dari petani sebaya, petani tua dan petani muda atas pengetahuan dan teknologi yang disampaikan?
4. Bagaimana perubahan pengetahuan dari teman sebaya, petani lebih tua dan petani lebih muda setelah pengetahuan disampaikan?
5. Apakah ada pengetahuan dan teknologi yang disampaikan oleh petani sebaya, petani yang lebih tua dan petani yang lebih muda?
6. Bagaimana tanggapannya terhadap pengetahuan dan teknologi yang disampaikan oleh petani sebaya, petani yang lebih tua dan petani lebih muda usianya?
7. Apakah pengetahuan dan teknologi disampaikan oleh petani sebaya, petani yang lebih tua dan petani yang lebih muda memiliki manfaat dan dampak terhadap usaha tani? Apa manfaat dan dampaknya?
8. Apakah pengetahuan dan teknologi yang diterima dari petani sebaya, petani lebih tua dan petani yang lebih muda langsung dipraktekan?
9. Apasaja kesulitan dalam berbagi pengetahuan dan teknologi dari petani sebaya, petani yang lebih tua dan petani yang lebih muda?

C. Hambatan, Dinamika Akses Pengetahuan dan Faktor-Faktor Struktural

1. Bagiamana respon dan tanggapan dari petani tua dan petani muda dalam menerima informasi pengetahuan dan teknologi baru?
2. Apakah pernah gagal dalam membuat produk olahan kelapa? Apasaja kegagalanyang di alami dan Bagaimana cara mengatasi kegagalan tersebut?
3. Apasaja faktor struktral yang jadi penghambat dalam mengakses lahan, teknologi, modal? Bagaaimana cara mengatasi faktor-faktor penghambat tersebut?

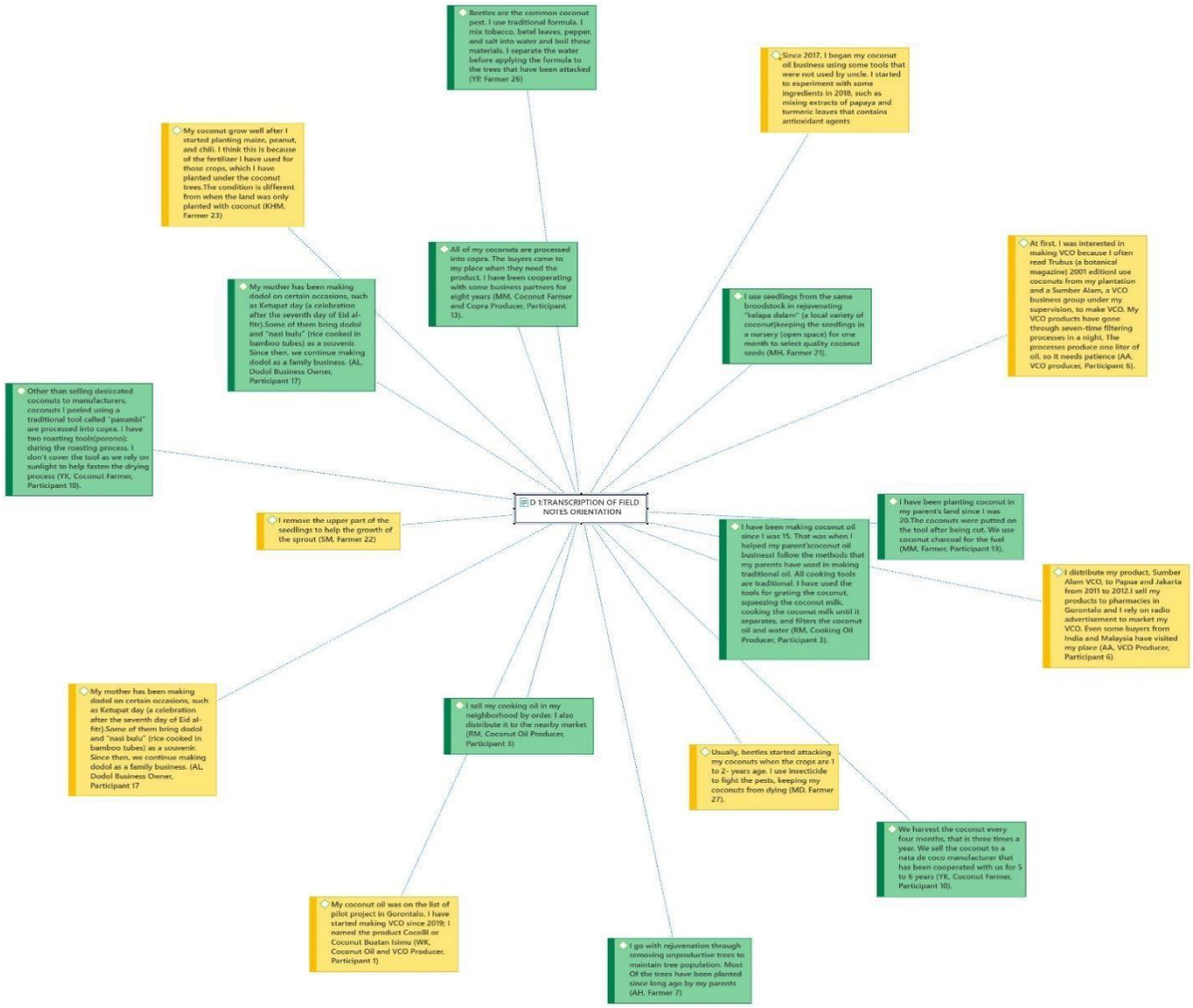
Lampiran Topik 2. Karakteristik Informan Penelitian

No/ Inisial Petani	Karakeristik Sosial Ekonomi Petani Kelapa Informan Penelitian								Durasi wawancara (menit)
	Kategori Generasi Petani		Luas Lahan (hektar)	Tingkat Pendidikan	Pengalaman Bertani /olahan (tahun)	Kategori Aktivitas			
	Muda 20-45 tahun	Tua 46-65 tahun				Budidaya	Pengolahan	Tujuan Pemasaran	
1. SA	42	-	3	Sarjana	20	Kelapa	Buah segar	Pedagang penumpul	75
2. AS	-	50	3	SMP	30	kelapa	Kopra	pabrik	35
3.RM	-	60	1	SD		kelapa	Pembuat minyak kelapa kampung	Pasar, tetangga	30
4. T	43	-	17	S2	5	Kelapa	VCO, buah segar	Pabrik	65
5. SZ		57	4	SD	27	Kelapa	Buah segar	Pedang pegumpul	30
6. AA	44	-	3	Sarjana-	18	kelapa	VCO	Apotik, keluar daerah	40
7. AH		50	10	SMP	15	kelapa	Pembuat Kopra	Pabrik kopra	30
8. YH	-	59	2	SMP	29	Kelapa	Pembuat Kopra, buah segar	Pabrik kopra	30
9. KN	45	-	1	SMA	10	kelapa	VCO dan Kue olahan kelapa	Pasar, supermarket	40
10.YK	-	51	1,5	SMA	36	kelapa	Kopra, Buah segar	pabrik	35
11.SM	-	69	1	SD	38	kelapa	Kopra, buah segar	Pedagang pengumpul	30
12.AB	-	60	3	SMA	30	kelapa	Kopra, buah segar	Pabrik, pedagang pengumpul	35
13.MM	-	67	5	SMP	20	kelapa	Kopra, buah segar	Pabrik, pedagang pengumpul	30
14. SU	37	-	1	SMA	5	kelapa	Pengrajin bonsai kelapa	Pameran	40
15.TN		47	1	SMA	20	kelapa	Pembuat olahan dodol	Pasar, bandara dan luar daerah	35
16.WK	25	-	3	Sarjana	4	kelapa	Miyak kelapa kampung, VCO, kopra putih	Luar daerah, pameran	75
17.AL	20		1	SMA	2	kelapa	Pembuat dodol	Luar daerah	40
18.OP	-	51	3	SMA	19	kelapa	Kopra, buah segar	Pabrik, pedagang pengumpul	35
19.LA	-	48	2	SMA	15	kelapa	Kopra,buah segar	Pabrik, pedagang pengumpul	35
20.HH	29	-	3	Sarjana	8	kelapa	Penagkar	petani	40

No/ Inisial Petani	Karakeristik Sosial Ekonomi Petani Kelapa Informan Penelitian								Durasi wawancara (menit)
	Kategori Generasi Petani		Luas Lahan (hektar)	Tingkat Pendidikan	Pengalaman Bertani /olahan (tahun)	Kategori Aktivitas			
	Muda 20-45 tahun	Tua 46-65 tahun				Budidaya	Pengolahan	Tujuan Pemasaran	
							bibit kelapa		
21.MH	-	55	5	SMA	20	kelapa	Kopra, penangkar bibt, buah segar	Pabrik, pedagang pengumpul, petani	30
22.SM	44	-	2	Sarjana	5	Kelapa, padi sawah	Buah segar, VCO	Pasar, pedagang pengumpul	35
23.KH	44	-	30	SMA	10	Kelapa, jagung, cabai, kacang tanah	Kopra, kopra putih, buah segar	Pabrik, pedagang pengumpul	30
24.AH	43	-	2	SMP	7	Kelapa, jagung, kacang tanah	Kopra, buah segar	pedagang pengumpul	35
25.AB	-	70	2	SD	40	Kelapa, jagung	Kopra, buah segar	pedagang pengumpul	30
26.YP	-	60	2	SD	30	Kelapa dan jagung	Kopra, buah segar	pedagang pengumpul	30
27.MD	29	-	1	Sarjana	5	Kelapa, jagung	Kopra putih, buah segar	Pabrik, pedagang pengumpul	45
28.HG	-	68	20	SMP	44	Kelapa, jagung	Kopra, buah segar	Pabrik, pedagang pengumpul	30
29.RH	-	40	4	SMA	5	Kelapa	Buah segar	Pabrik, pedagang pengumpul	40
30.RA	31	-	1	Sarjana	6	Kelapa, jagung	Kopra putih, buah segar	Pabrik, pedagang pengumpul	45

Lampiran 3. Hasil Olahan Pengumpulan Data Menggunakan Aplikasi Atlas.ti

a. Orientasi Tindakan Petani Tua dan Petani Muda



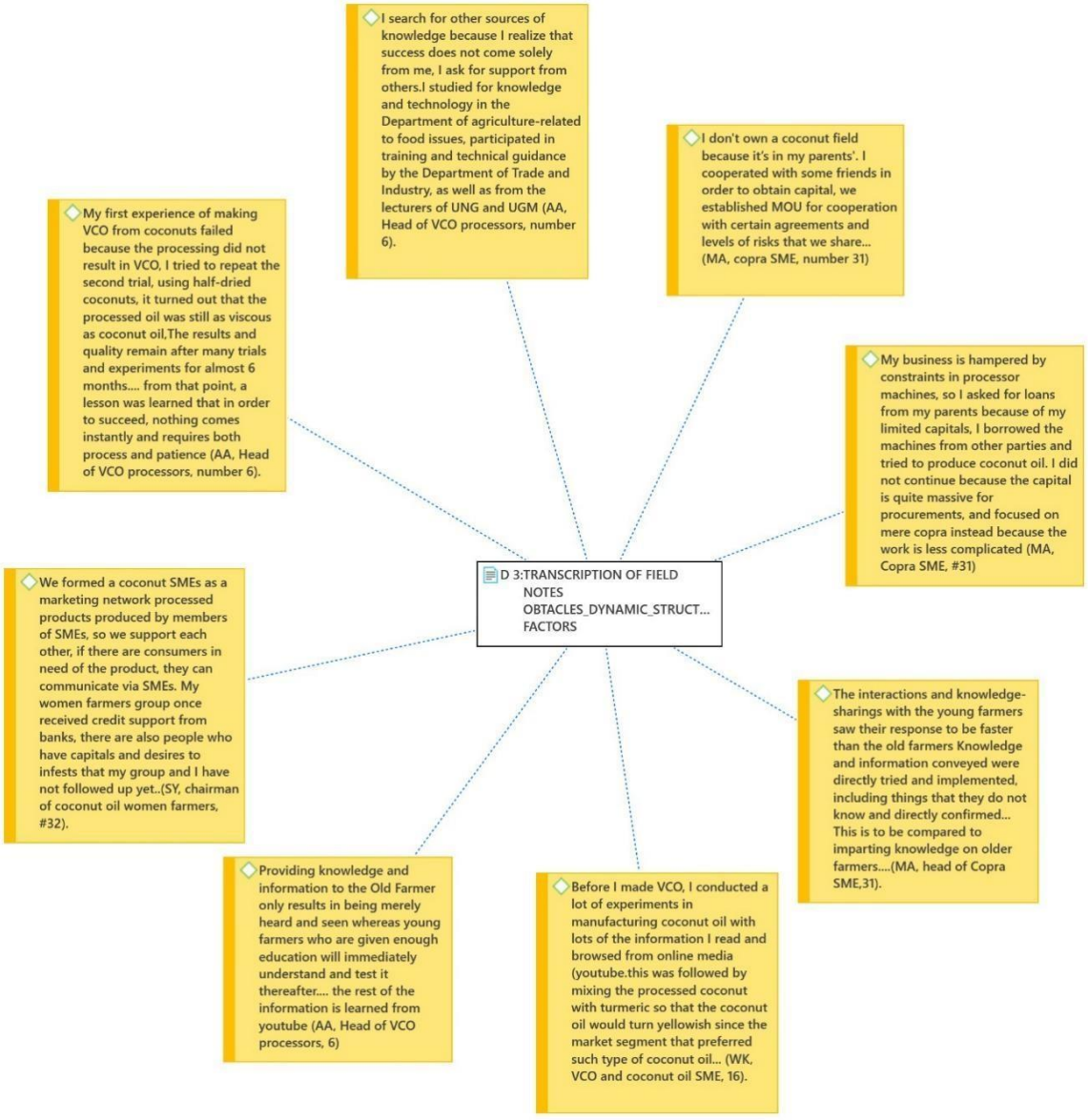
Note :

Transkripsi Petani Tua	Transkripsi Petani Muda

b. Knowledge Co Creation Petani Tua Dan Petani Muda

Note : Transkripsi Petani Tua | Transkripsi Petani Muda

c. Hambatan, Dinamika dan Faktor Pengetahuan Petani



Transkripsi Petani Muda

Lampiran Topik 3. Karakteristik Informan Usaha Tani Jagung dan Kelapa.

No/ Inisial Petani	Karakeristik Sosial Ekonomi Petani jagung dan Kelapa Informan Penelitian								Durasi wawancara (menit)
	Kategori Generasi Petani		Luas Lahan (hektar)	Tingkat Pendidikan	Pengalaman Bertani /olahan (tahun)	Kategori Aktivitas			
	Muda 20-45 tahun	Tua 46-65 tahun				Budidaya	Pengolahan	Tujuan Pemasaran	
1. AB	-	54	2	SMA	21	Jagung	Jagung Pipilan	Pabrik, Pedagang penumpul	30
2. OP	-	51	3	SMA	19	Jagung dan kelapa	Jagung pipilan, Kopra, buah segar	Pabrik, pedagang pengumpul	35
3. AD	-	58	1	SMP		Kelapa	Kopra, arang tempurung	Pabrik	30
4. JF	44	-	2	SMA	12	Jagung	Pia jagung, tepung jagung	Supermarket, pasar luar daerah	60
5.WK	25	-	3	Sarjana	4	Kelapa	Miyak kelapa kampung, VCO, kopra putih	Luar daerah, pameran	75
6. AA	44	-	3	Sarjana	18	Kelapa	VCO	Apotik, keluar daerah	40
7. UH	-	60	2	SD	30	Jagung	Jagung pipil	Pedagang pengumpul	25
8. MM	-	67	5	SMP	20	Kelapa	Kopra, buah segar	Pabrik,pedagang pengumpul	30
9.AW	43	-	10	SMA	25	Jagung	Jagung pipil, pakan ternak	Pasar luar daerah	65
10.YL	-	68	4	SD	22	Jagung dan kelapa	Jagung pipil	Pedagang pengumpul	30
11. YN	-	59	2	SMP	29	Jagung	Jagung pipil	Pedagang Pengumpul	32
12.AB	-	60	3	SMA	30	kelapa	Kopra, buah segar	Pabrik, pedagang pengumpul	35
13.MM	-	67	5	SMP	20	kelapa	Kopra, buah segar	Pabrik, pedagang pengumpul	30
14. SU	37	-	1	SMA	5	kelapa	Pengrajin bonsai kelapa	Pameran	40
15.TN		47	1	SMA	20	kelapa	Pembuat olahan dodol	Pasar, bandara dan luar daerah	35
16.WK	25	-	3	Sarjana	4	kelapa	Miyak kelapa kampung, VCO, kopra putih	Luar daerah, pameran	75
17.AL	20		1	SMA	2	kelapa	Pembuat dodol	Luar daerah	40
18.OP	-	51	3	SMA	19	kelapa	Kopra, buah segar	Pabrik, pedagang pengumpul	35

No/ Inisial Petani	Karakeristik Sosial Ekonomi Petani jagung dan Kelapa Informan Penelitian								Durasi wawancara (menit)
	Kategori Generasi Petani		Luas Lahan (hektar)	Tingkat Pendidikan	Pengalaman Bertani /olahan (tahun)	Kategori Aktivitas			
	Muda 20-45 tahun	Tua 46-65 tahun				Budidaya	Pengolahan	Tujuan Pemasaran	
19.LA	-	48	2	SMA	15	kelapa	Kopra,buah segar	Pabrik, pedagang pengumpul	35
20.HH	29	-	3	Sarjana	8	kelapa	Penagkar bibit kelapa	petani	40
21.MH	-	55	5	SMA	20	kelapa	Kopra, penangkar bibt, buah segar	Pabrik, pedagang pengumpul, petani	30
22.SM	44	-	2	Sarjana	5	Kelapa, padi sawah	Buah segar, VCO	Pasar, pedagang pengumpul	35
23.KH	44	-	30	SMA	10	Kelapa, jagung, cabai, kacang tanah	Kopra, kopra putih, buah segar	Pabrik, pedagang pengumpul	30
24.AH	43	-	2	SMP	7	Kelapa, jagung, kacang tanah	Kopra, buah segar	pedagang pengumpul	35
25.AB	-	70	2	SD	40	Kelapa, jagung	Kopra, buah segar	pedagang pengumpul	30
26.YP	-	60	2	SD	30	Kelapa dan jagung	Kopra, buah segar	pedagang pengumpul	30
21.MH	-	55	5	SMA	20	kelapa	Kopra, penangkar bibt, buah segar	Pabrik, pedagang pengumpul, petani	30

Lampiran Tabel 4. Persamaan Pernyataan Informan dan Pemaknaan Informan Tentang Aspek Budidaya, Pengolahan dan Pemasaran Usaha Tani Kelapa dan Usaha tani Jagung

Inisial Informan (1)	Aspek Usahatani (2)	Persamaan Pernyataan Informan (3)	Pemaknaan Informan terhadap Pernyataan dimaksud (4)
YP, UH, KN,AS, AB,GR,SM,YH,SG,RH, AP,SE	Budidaya Jagung	Sumber pengetahuan petani	Umumnya informan menyampaikan sumber pengetahuan budidaya usahatani jagung diperoleh dari orang tua, orang yang memiliki hubungan kekerabatan, generasi sebelumnya, aktor dan lembaga lain
YP,UH, AB,YS,SZ,GFR,YH,SG, SE,OP,SM,IH	Budidaya Jagung	penggunaan benih	Informan menyampaikan penggunaan benih lokal, penggunaan benih hybrida dan Komposit
SM, LA, YS, UH,SM,YH, SG,AP	Budidaya Jagung	pengolahan tanah tradisional	Informan menyampakan ada yang mengolah tanah masih menggunakan bajak tenaga sapi
OP, NH, AB,SM,MA,SR	Budidaya Jagung	pengolahan tanah dengan teknologi Alsintan	Informan menyampaikan pengolahan tanah sudah menggunakan hand traktor dan zoonder (alsintan)
AS, YS,SG,SE	Budidaya jagung	Pengendalian hama dan penyakit	Informan menyampaikan sistem pengendalian hama dan penyakit masih menggunakan pengetahuan lokal yang didapatkan dari generasi sebelumnya
JF, EH, MM,RD	Pengolahan jagung	Inovasi pengolahan jagung	Informan menyampaikan olahan jagung dalam bentuk tepung jagung, stick jagung, panada tore
OP, NY, AW, SM, AB,AR	Panen dan pascapanen	Penggunaan alat dan mesin panen serta pascapanen	informan menyampaikan penggunaan lantai jemur mesin pemipil/perontok jagung, mesin pengering (dryer cerobong)
AW, OP, AR,NY,YP,UH, IH,AT	Pemasaran	Tujuan pemasaran petani jagung	informan menjual jagungnya ke pedagang pengumpul. Pedagang besar, pabrik dan pemasaran luar daerah
AS, MM, AM,YP, UH	Budidaya Kelapa	Sumber pengetahuan	Informan petani menyampaikan bahwa sumber pengetahuan budidaya kelapa diperoleh dari generasi sebelumnya, umumnya yang memiliki hubungan kekerabatan (orang tua, kerabat), misalnya dalam pemilihan buah kelapa menjadi bibit
AH,MH.KHM	Budidaya Kelapa	Keberlanjutan usahatani kelapa	Informan petani menyampaikan untuk mempertahankan eksistensi kelapa dengan melakukan peremajaan tanaman kelapa yang kurang produktif (umur tanaman lebih dari 30 tahun, ada juga informan petani yang menggunakan tanaman sela di lahan kelapa seperti jagung, kacang tanah, cabai untuk meningkatkan pendapatan usahataninya
YK,MM,AH,LA	Budidaya Kelapa	pengolahan tanah secara tradisional	Informan petani mengolah tanah tanah dengan bajak sapi dengan alasan supaya tanah menjadi gembur dan subur
YK,OP	Budidaya Kelapa	Penggunaan teknologi alsintan	Informan petani melakukan pengolahan tanah dengan traktor zoonder
MH,HH	Budidaya Kelapa	pemilihan benih lokal	Informan petani menggunakan bibit kelapa lokal yang unggul, penggunaan metode sayatan pada bibit kelapa
MD,YP	Budidaya Kelapa	pengendalian hama dan penyakit	Informan petani menyampaikan metode pengendalian hama kumbang, babi hutan dengan cara tradisional dan penggunaan

Inisial Informan (1)	Aspek Usahatani (2)	Persamaan Pernyataan Informan (3)	Pemaknaan Informan terhadap Pernyataan dimaksud (4)
			insektisida
RM,SA,OP,YH,AS, LA,MH,RA,MD	Pengolahan kelapa	Olahan kelapa dari generasi sebelumnya	Informan petani menyampaikan masih membuat olahan kelapa menjadi kopra, arang tempurung, minyak kelapa tanak yang pembuatannya masih tradisional
WK,AA,YK,MA,SA,KN, MD,MJ,AB, MD,AI	Pengolahan Kelapa	Olahan Kelapa yang memiliki nilai ekonomis	Informan petani menyampaikan mengolah kelapa menjadi Minyak kelapa yang peralatannya sudah menggunakan peralatan yang semi modern *Virgin Coconut Oil*, Kopra putih, ada juga yang menjual dalam bentuk kelapa segar ke pabrik kelapa
AL,KN, TR, MJ	Pengolahan Kelapa	Produk olahan berbahan kelapa	Informan petani menyampaikan membuat produk olahan dalam bentuk Kue, dodol
YK,AA.WK,RH, AB,HG,MD	Pemasaran Kelapa	Penjualan ke pedagang pengumpul, pabrik dan pemasaran luar daerah	Informan petani menyampaikan menjual produk kelapa ke luar daerah/luar negeri

DOKUMENTASI PENELITIAN USAHA TANI JAGUNG

Alat Pengolahan bajak " Popadeo" menggunakan tenaga hewan

Alat HandTraktor untuk olah TanahJagung

Alat Zonder untuk olah Tanah Jagung

Salah Satu Olahan Bepang Jagung

Olahan Pia Jagung dan Tepung Jagung

Salah satu inovasi petani untuk hamapenyakit

Alat Tugal Petani untuk penanaman Jajar Legowo

Metode Pemupukan interaksi Petani Tua dan Petani Muda

Bersama Petani Tua dan Petani Muda Setelah Penanaman

DOKUMENTASI PENELITIAN USAHA TANI KELAPA

Alat “Pasumbi”, Alat Kupas kelapa sederhana

“Porono”, tempat pembakaran kopra asalan, dari kayu

Pembuatan Minyak kelapa Tanak menggunakan alat tradisonal

Pembuatan Minyak kelapa Tanak menggunakan alat semi Moderen

Pembuatan VCO melalui proses penyaringan

Pembuatan Dodol, dari tepung dan santan kelapa

Submission in ScholarOne

SOCIAL NETWORK OF KNOWLEDGE SOURCES AND INNOVATION BETWEEN GENERATIONS FOR CORN ECOLOGICAL SUSTAINABILITY IN GORONTALO REGENCY, INDONESIA

Abstract: Knowledge and technology are one of the main key to agricultural innovation. However, the availability of knowledge as the basis for innovation must be accessible to farmers easily and sustainably. This study aimed to find out the knowledge sources of farmers and how the social network of innovation develops corn farming, especially in the cultivation, processing, and marketing aspects. This study used the grounded theory method through in-depth interviews and then processed using open, axial and selective coding. This study involved 26 farmers, consisting of 12 old farmers (46-65 years old) and 14 young farmers (25-45 yearsold). The novelty of this study is how intergenerational social networks and access to innovation were used to identify social networks as sources of invention for both young and old farmers in corn farming practices that have been ecologically sustainable. Based on the results, there were differences in knowledge sources and social network innovation between old farmers and young farmers for corn ecological sustainability. Old farmers had the main source of local and traditional knowledge from previous generations, while young farmers had the main source of knowledge from a combination of local and modern knowledge with innovations from various actors and institutions through social media in developing corn farming.

Keywords: Social Network, Knowledge Sources, Innovation, Ecological Sustainability

Introduction

Social network among farmers has a significant role in the exchange of knowledge and innovation in agriculture. The social network of farmers can increase the amount of information and knowledge exchange from different networks of farmers (Skaalsveen *et al*., 2020); increase

the adoption of new technologies through information and knowledge (Garforth *et al*., 2003); provide innovation and knowledge (Cofré-Bravo et al., 2019); and to influence decision making (Skaalsveen *et al*., 2020). Skaalsveen et al., (2020) found that intermediary farmers have a very important role, because intermediary farmers are seen as having a high level of knowledge and experience in the social network of farmers. The importance of intermediary farmers is in accordance with the study on innovation adoption by Wood *et al*., (2014) where farmers take information and ideas from other farmers.

Social networks in agriculture are related to knowledge because social relations between farmers are very important for the development of knowledge sharing among farmers (Tsouvalis *et al*., 2000). Based on previous studies, knowledge focused on individuals as the main actors to solve the problems of farmers, but in further developments, the role of other actors (workers, partners and family members, advisors and officials) acts as knowledge sources for farmers (Thomas *et al*., 2020). According to Wójcik *et al*., (2019) the difference inclassification between knowledge sources will not hinder the interaction process, because the formation of knowledge sources is very complex and closely related to place, environment, local knowledge, culture and regional economy. According to Lwoga *et al*., (2010) the participation of the community and the environment in knowledge creation aims at sustainable agricultural development, because knowledge creation continuously will distribute and share knowledge within and outside the community so that ultimately there will be integration between technology, innovation, and new agricultural knowledge.

Cofré-Bravo *et al*., (2019) stated that innovation in agriculture requires access to resources such as knowledge, finance, training and emotional support and even support from actors such as peers, advisors and researchers. According to Ribot & Peluso (2003) access is all ways of supporting a person to benefit from various things. Access to resources to produce agricultural innovation is influenced by social networks because agricultural innovation is a diverse system

involving many actors from the public, private, and civil sectors, so these innovations can bring new ideas, practices, and products into the agricultural system of diverse small farmers (Klerkx *et al*., 2012; Spielman *et al*., 2011). Knowledge is embedded or intentionally created to support and assist innovation to provide knowledge relevant to otherresources (Mc Fadden, 2016; Klerkx *et al*., 2012; Van Rijn *et al*., 2012; Hilkens *et al*., 2018). **Other relevant factors in the social network of farmers, which constitute the primary topic of this research, are knowledge sources based on knowledge co-production and knowledge co-creation since the topic is a determining factor for collaboration between local knowledge which is typically obtained from farmers' experience and scientific knowledge. In such cases, a knowledge gap often exists, and farmers require assistance from other individuals to take advantage of knowledge sources. This is in line with Arifah et al.'s research findings (2023), that active participation as a joint effort and collaboration between farmers and stakeholders, in this case, policymakers, farmers, and institutions development, determines the success of knowledge co-production-based knowledge source. The knowledge source based on knowledge co-creation is the impact of repeated interactions and knowledge sharing between farmers resulting in a new peasantry, this is following the research findings by Tolinggi et al., (2023), that the sustainability of coconut farming is due to the results of knowledge co-creation from the engagement between old and young farmers.**

Corn is a socio-ecological commodity in Gorontalo, because historically, corn has been cultivated for decades in Gorontalo and even nationally, Gorontalo is included in the 10 (ten) contributors to national corn production. In 2002, the Gorontalo Provincial Government made corn one of the regional superior commodities (NSLC, 2018) but the superiority of corn commodity in Gorontalo has not been fully accompanied by the adoption of technological innovations by farmers in the management of corn crops. This is in line with a study by Sumarno & Hiola (2017) that the adoption of innovation by farmers towards the technology component of integrated corn crop

management in Gorontalo Regency has not been optimal in both low land and high land agroecosystems. Furthermore, Sumarno & Hiola (2017) stated that increasing access to sources of technological innovation can be performed by increasing the frequency of outreach and dissemination of technology to all farmers. Cofré-Bravo *et al*., (2019) found that in the innovation process, farmers are always looking for the latest innovations and technologiesto avoid risks so that farmers apply proven technology more to their agricultural practices. However, Cofré-Bravo *et al*., 2019) did not explore further the relationship between the social network of knowledge sources and innovation with the ecological sustainability of commodities.This study focused on identifying sources and innovations for old farmers and young farmers for corn ecological sustainability, especially in the cultivation, processing, and marketing aspects, h**ence, this research is crucial in providing better understand who the sources and innovators of knowledge are as well as how social networks between old and young farmers are formed regarding these aspects of cultivation, processing, and marketing in relation to the sustainability of corn farming. (point 1 reviewer's Comments)**

This study's findings are consistent with earlier studies in that social networks between actors are necessary for access to innovation. The study differs from other research in that it describes how older and younger farmers access innovation differently through social networks and discusses how this access relates to ecological sustainability in farming methods across generations.

Materials and Methods

This study used a qualitative research approach with grounded theory and exploratory methods (Corbin & Strauss, 1990). This method was chosen to guide data collection to provide a more profound understanding of the social network, knowledge sources, access to innovation, and other actors for corn farming sustainability.

The samples of this study were old farmers and young farmers on the coconut-corn intercropping farm. This study used the Badan Pusat Statistik category with old farmers aged 46-65

years and young farmers aged 25-45 years. The samples were distributed over 3 sub- districts in Gorontalo Regency, namely Bongomeme Sub-District, Tibawa Sub-District, and Pulubala Sub-District (Figure 1).

Figure 1. Location Map

Researcher interviewed 26 farmers as research informants consisting of 12 old farmers and 14 young farmers (The author adds 5 statements of informants to support references in the discussion about the ecological sustainability of corn from old and young farmers in underpinning the revision of point 5 of the reviewer comments). The selection of farmer informants was purposeful by choosing farmer group administrators to be interviewed. The farmer group administrators were selected based on several considerations, information, and recommendations from several parties, including extension workers, village government officials, and development program assistants. Next, once no more information was relevant to the research theme, the researcher stopped interviewing informants/data saturation and gathering data.

This number refers to the saturation criterion by Corbin & Strauss (1990) were the interview ends or is terminated if no new information emerges (Cofré-Bravo *et al*., 2019). Researchers phoned the farmers who wanted to be interviewed, and after the respondents agreed, researchers then conducted the interviews face-to-face. The interviews were started with open-ended questions and then structured questions according to the topic.All answers were recorded and transcribed for a duration of 30-75 minutes. Researchers also asked old farmers and young farmers about knowledge sources and access to social network innovation.

Data were analyzed with open, axial and selective coding referring to Corbin & Strauss, (1990). In open coding, researchers identified and looked at the answers from informants to assess whether or not they were related to the study in the form of transcription notes and coded according to relevant concepts. After the open coding, the data were analyzed with axialcoding to generate categories. According to Bertolozzi-Caredio *et al*., (2020) axial coding wasprocessed through deletion, purification, and integration, so that the resulting data were morecomprehensive and meaningful. According to Corbin & Strauss (1990) in the axial coding stage, data were linked with subcategories, tested with other data and linked between categories. In the final stage, researchers conducted selective coding by presenting the resultsof interviews by building these sub-categories according to the focus of the study (Salman et al., 2021). Researchers used the ucinet 6 application version 6.746 to see the network structure of knowledge sources and innovations from old farmers and young farmers in corn farming distinguished by cultivation, processing, and marketing aspects.

Results and Discussion

Social Network of Knowledge Sources between Old Farmers and Young Farmers

There were differences in knowledge sources between old farmers and young farmers in corn farming. Differences in knowledge sources are categorized into three aspects namely

cultivation, processing, and marketing aspects. Differences in knowledge sources between old farmers and young farmers in corn farming are presented in Table 1.

Table 1. Knowledge Sources between Old Farmers and Young Farmers in Corn Farming

Aspect	Differences in Knowledge Sources	
	Old Farmers	**Young Farmers**
Cultivation	Parents from generation to generation, Panggoba, Relatives, Head of Farmer Groups, and Extension Officers.	Relatives, Extension Officers, Agricultural Offices, Universities, BPTP Researchers, Online Media (Youtube), and Distributors of Fertilizers and Seeds.
Processing	Parents from generation to generation.	Bank Indonesia, Koperindag, Universities, Online Media (Youtube), Food Office, Corn SMEs.
Marketing	Collector farmers, relatives, heads of farmer groups.	Corn SMEs, corn factories/entrepreneurs outside Gorontalo, Online Media (Whatsapp group), and Associations.

Source: Primary data processed from research informants, 2021

Cultivation Aspect of Corn Farming

Knowledge sources in the cultivation aspect of old farmers and young farmers had differences.Old farmers generally get knowledge of corn cultivation and farming from previous generations (parents, relatives), regional agricultural leaders (panggoba), head of farmer groups, and extension officers. This is the following interview with old farmers:

> *I got a lot of knowledge on how to grow corn and coconuts from my parents, Ialso learned from Panggoba and agricultural extension workers (YP, Corn and Coconut Farmer, number 9).*
>
> *I got agricultural knowledge from my parents, members of farmer groups, and some from panggoba or people considered to have local knowledge, especially astrology (UH, Corn Farmers, number 19).*
>
> *I got knowledge on how to grow corn from my parents and relatives of fellow farmers, then I combined it with the knowledge I got from agricultural extension workers (OP, Corn Farmer, number 4).*

Young farmers have a variety of knowledge sources regarding corn cultivation from various parties including. Gorontalo BPTP researchers, universities, extension workers, online media (YouTube), Regency and Gorontalo Province Agricultural Offices,

fertilizer and seed distributors. These are the results of interviews with young farmers:

> *I learned how to grow corn from farmers who are my relatives in this village. At first, I used the regular planting system, but now I've used the jajar legowo system,I saw a lot of information from youtube, and the results from the legowo system were pretty good. I also learned about corn cultivation techniques from Youtube, such ashow to trim the leaf branches during the fertilization process, I trim the leaves at the bottom of the stem so that the nutrients go directly to the corn fruit. Students from UG and UNG have also carried out corn farming counselling in this village (AM, Corn Farmers, number 14).*

> *Sources of knowledge on processing, seeding, and fertilizing corn were obtained from seminars and training conducted by the Regency Agriculture Office for 2 weeks in 2007. In 2018, researchers from BPTP once made a corn demonstration plot here. Farmers group members and I also learned a lot about corn cultivation, especially planting techniques, corn varieties, and how to controlpests and diseases (MG, Corn Farmers, number 13).*

> *I learned agriculture from extension workers, I also participated in many trainings, through comparative studies funded by the Provincial Agriculture Office, fertilizer and seed distributors, I also attended the training which I paid for myself (AW, Corn Farmer, number 17).*

The social network of knowledge sources of old farmers and young farmers in the cultivation aspect of corn farming can be seen in Figure 2.

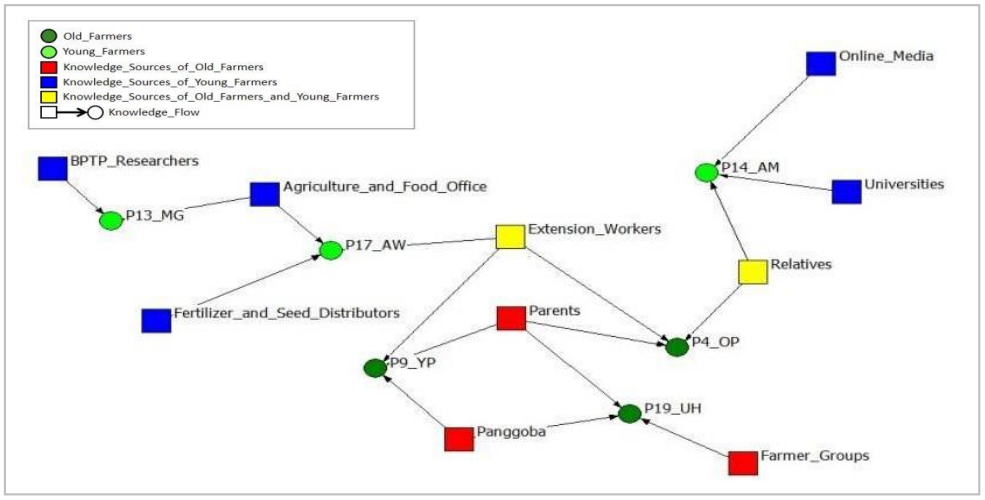


Figure 2**.** The social network on knowledge sources of old farmers and young farmers in the cultivation aspect of corn farming

Based on Figure 2, old farmers (P4, P9, and P19) had knowledge sources on corn

cultivation from parents, panggoba, and farmer groups, while young farmers (P13, P14, and P17) had knowledge sources from BPTP researchers, Agriculture and Food Office, fertilizer and seed distributors, universities, and online media. Extension workers and are still becoming knowledge sources for old farmers and young farmers.

Processing Aspect of Corn Farming

Knowledge of old farmers on corn processing only comes from parents from generation to generation. Corn processing is only for consumption needs, where corn is boiled with lime sothat the corn is softer to be consumed in addition to being grilled. This is an interview with old farmers:

> *My wife uses lime to boil corn so that the corn is not hard when consumed, this knowledge comes from our parents (YL, Corn and Coconut Farmer, number 20).*
>
> *My parents taught me to make boiled and grilled corn, usually using grated coconut mixed with papaya leaves or banana blossoms, sliced chillies, and onions (MP, Corn and Coconut Farmer, number 2).*

Young farmers gain knowledge about processed corn with commercial and selling values, including corn flour, corn pie, corn sticks, and corn pastels. The main knowledge sources were Bank Indonesia, Recy and Provincial and Regency Cooperatives, Industry and trade, Universities, online media (YouTube), Food Office, and Corn SMEs. These are the results of interviews with young

farmers below:

> *I got knowledge on manufacturing processed corn into corn flour from the Regency and Provincial Koperindag, cooperation with Bank Indonesia, including training in making corn flour conducted by Universitas Negeri Gorontalo lecturers (JF, Corn Farmer, number 18).*
>
> *I process corn into corn stick products. I first learned from YouTube, and after that, I took part in the training conducted by the Regency Food Office after I joinedthe SMEs (MD, Corn Farmer, number 10).*

Knowledge sources of corn farming processing between old farmers and young farmers canbe

seen in Figure 3 below.

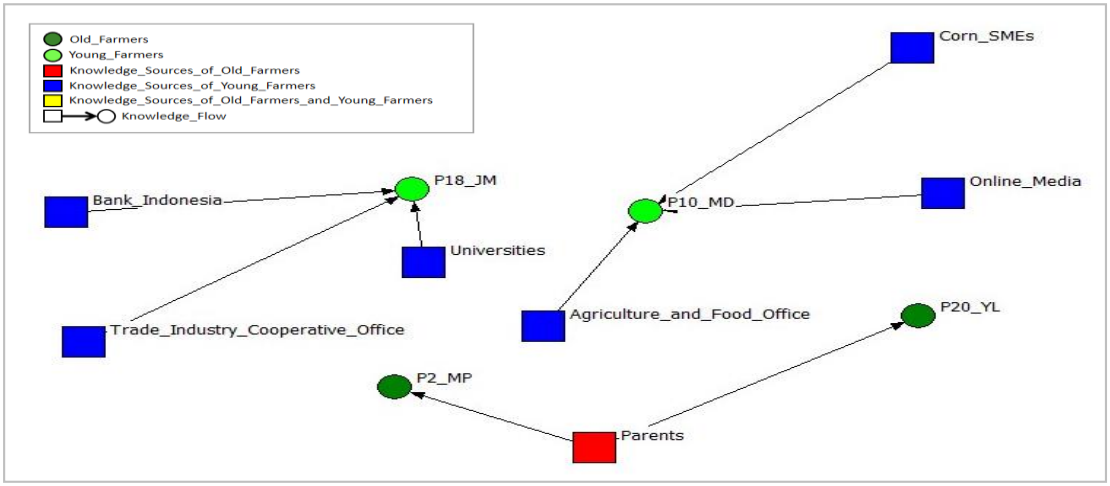


Figure 3**.** Social Network on Knowledge Sources of Old Farmers and Young Farmersin Processing Aspect of Corn Farming

Based on Figure 3 old farmers (P2 and P20) had knowledge sources on corn processing from parents, panggoba, and farmer groups, while young farmers (P10 dan P18) had knowledge sources from Corn SMEs, Agriculture and Food Office, universities, online media, and Bank Indonesia.

Marketing Aspect of Corn Farming

Corn marketing between old farmers and young farmers is different due to differences in knowledge sources. Knowledge sources of old farmers in corn marketing come from collecting traders, heads of farmer groups, This is the interviews with old farmers:

> *I received information on corn prices from and farmer groups (YL, Corn and Coconut Farmer, number 20).*

> *I learned about corn marketing information from who is also a member of a farmer group in a neighbouring village. I sell my harvest to collectorsto save on transportation costs (AH, Corn Farmer, number 19).*

Young farmers have high motivation to market corn outside Gorontalo because it has a significant price difference between corn prices in Gorontalo such as Makassar and Surabaya.This knowledge comes from corn SMEs, corn entrepreneurs outside Gorontalo, online media

(Whatsapp group), and corn entrepreneur associations. These are the results of interviews with young farmers.

> *I got information directly from corn factories in Surabaya and Makassar because prices are higher than in Gorontalo, (AW, Corn Farmer, number 17).*

> *Marketing information for corn flour and corn pie is obtained through WhatsApp groups, associations, SMEs, and entrepreneurs of processed corn products from outside Gorontalo, namely Manado, Makassar, and Jakarta… (JF, Corn Farmer, number 15).*

The social network of knowledge sources of old farmers and young farmers in the marketing aspect of corn farming can be seen in the following figure 4 below.

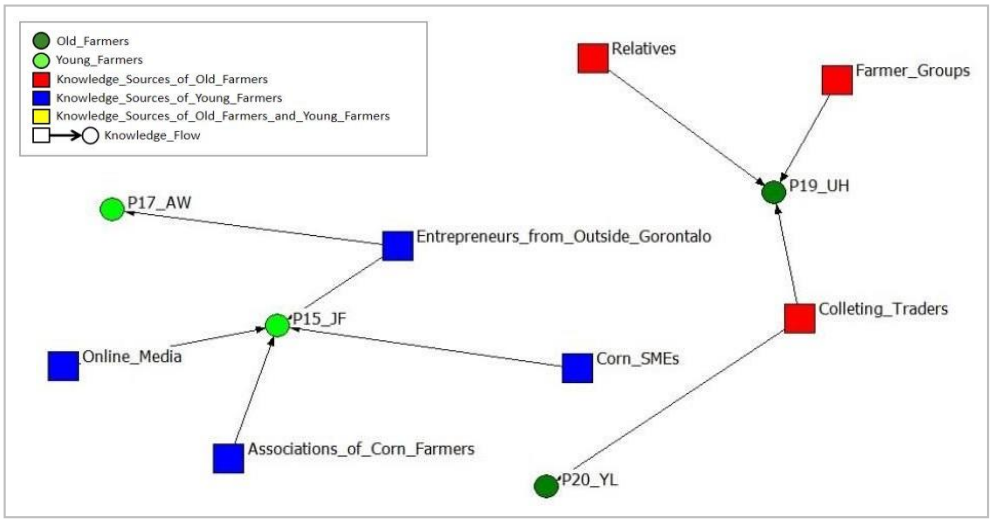


Figure 4. Social Network on Knowledge Sources of Old Farmers and Young Farmers in Marketing Aspect of Corn Farming

Figure 4 exhibited that old farmers (P20 and P19) had knowledge sources on corn marketing from collecting traders, farmer groups, while young farmers (P15 and P17) had knowledge sources from online media, corn SMEs, associations of corn farmers andentrepreneurs from outside Gorontalo.

The difference in knowledge sources between old farmers and young farmers in the cultivation, processing, and marketing aspects of corn farming is an interesting phenomenon. In general, knowledge of old farmers is considered traditional local knowledge sourced from parents,

relatives, and panggoba from generation to generation combined with knowledge fromfarmer groups and agricultural extension workers. This is different from young farmers who can combine knowledge from several stakeholder actors and online media, including agricultural extension workers, BPTP researchers, Food Office, Koperindag, Universities, agricultural extension workers, online media (YouTube and WhatsApp groups), banking, seed and fertilizers distributors, associations, SMEs, and corn marketing companies outside Gorontalo. This is also in line with a study by Šūmane *et al*., (2018) farmers are more appreciative of knowledge based on local experience witnessed directly, closely related to needs and personally acquainted with the main source of knowledge. The main source of knowledge for old farmers is kinship as a means of exchanging knowledge, this is also in line with a study by Ramirez, (2013) local and traditional knowledge passed down from generationto generation, generally from father to son or from relatives influences decision-making in adopting technology.

Knowledge sources of young farmers varied according to a study by Šūmane *et al*., (2018) young farmers individually can synthesize knowledge to integrate with various knowledge sources through multi-actor social networks, so that knowledge exchange occurs in realizing sustainable agricultural resilience. According to (Mills et al., 2019) the ability of young farmers to access knowledge sources through social media in the exchange and sharingof knowledge will increase knowledge.

Social Network on Innovation between Old Farmers and Young Farmers

This section identified social networks on innovation between old farmers and young farmers in the cultivation, processing, and marketing aspect. There were differences in innovation between old farmers and young farmers in corn farming as seen in Table 2.

Table 2. Innovation between old farmers and young farmers in corn farming

Aspect	Differences in Knowledge Sources	
	Old Farmers	**Young Farmers**
Cultivation	Ordinary planting methods, ploughs, corn seeders from wood, local/composite seeds, pest control using local wisdom.	Coconut-corn intercropping, legowo planting method, hand tractor/Zonder, superior seeds, corn seeders, integrated pest control, corn sheller machine, chimney dryer.
Processing	Consumption of local food (milu siram), a mixture of chicken feed.	Corn flour, corn pie, corn sticks, corn pastels, and corn starch.
Marketing	Corn collector traders, farmer group leaders.	Send samples to factories outside the area, and taste test.

Source: Primary data processed from research informants,2021

Social Network on Cultivation Innovation of Corn Farming

Innovation in the cultivation aspect between old farmers and young farmers had differences. Old farmers still apply traditional planting methods and equipment in the form of ploughs using cows in tillage and ordinary planting methods, wooden corn seeders, local/compositeseeds, and local pest control. This is the interview with old farmers:

> *Tillage the land using cattle plough 2 times, but before ploughing, I clean the weeds by trimming them with a machete. After ploughing, I drilled holes in the soil to plant seeds by manually digging them using wooden corn seeders with pointed ends (SM, Corn Farmer, number 8).*
>
> *The corn seeds planted by parents used to be local seeds such as Momala and Motorokiki corn seeds. The seeds to be planted must be soaked in water for at least 3 hours, and then drained. When planting the seeds (moludes), I use a corn seeder made of lamtoro wood with a pointed tip with 4 seeds in one hole (YH, Corn Farmer,number 12).*
>
> *The pest control techniques taught by the old people still exist and are appliedin this village. For rat pests, our parents use bulucui (small bamboo), and each bamboo segment is filled with water until it is full. Bamboo that has been filled withwater is planted by plugging it into every corner and the middle of the land. This method is usually effective for caterpillar pests (AK, Corn and Coconut Farmer, number 6).*

Young farmers have innovations in planting methods and the use of modern tools and

technology including planting corn under coconut trees (coconut-corn intercropping), the legowo planting method and the use of technological tools such as hand tractors and zonders,superior seeds, corn seeders, integrated pest control, machinery corn sheller, and chimney dryer. This is an interview with young farmers:

> *I plant corn under the shade of coconut trees to produce more due to the effectof fertilization on coconut and corn. I use the legowo system. I use a corn seeder so that the corn production increases. I also use a hand tractor and zonder with assistance from the provincial agriculture office (SD, Corn and Coconut Farmer, number 16).*

> *I use the legowo planting system, I use superior hybrid seeds since the Agropolitan program at the time of Governor FM. Urea fertilizers and compound fertilizers are used by the advice of extension workers, integrated pest control, use of machinery (tractors), use of corn shellers and chimney dryers, program assistance from the ministry of agriculture (MA, Corn Farmer, number 5).*

The social network on the innovation of old farmers and young farmers in the cultivation aspect of corn farming can be seen in Figure 5 below.

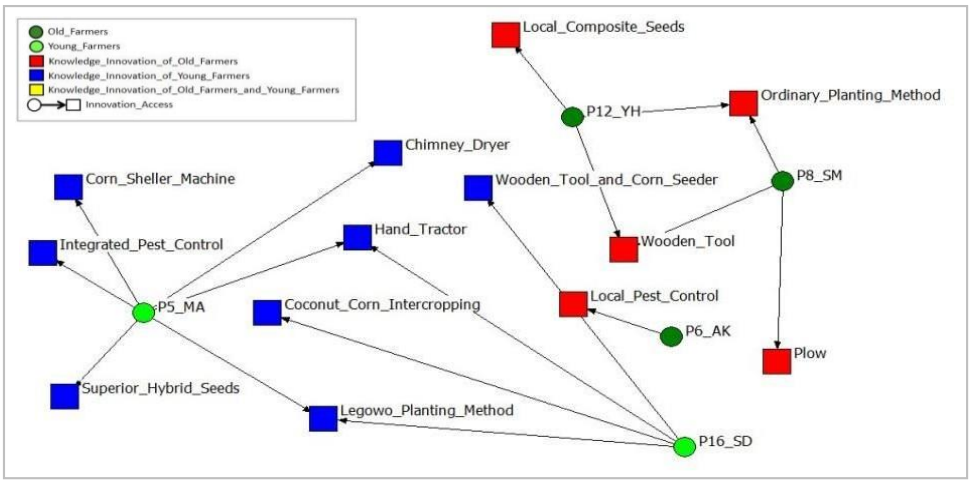


Figure 5. Social Network on Innovation of Old Farmers and Young Farmersin Cultivation Aspect of Corn Farming

Figure 5 showed old farmers (P6, P8, and P12) used local and traditional knowledge methods such as local pest control, used cattle power to plough and corn seeders from pointed wood, used local/composite seeds and ordinary planting methods, while young farmers (P5 and P16) used modern cultivation innovation, using superior hybrid seeds, legowo planting method,

coconut-corn intercropping, corn seeder, hand tractor, integrated pest control, corn sheller machine and chimney dryer.

Social Network on Processing Innovation of Corn Farming

Innovation in the processing aspect between old farmers and young farmers had differences. Old farmers lack innovation in processing corn into products with added economic value. Old farmers generally lack knowledge in corn processing because, after harvest, most of the corn is sold in a shelled form to factories or collecting traders. Corn is usually consumed as simplefood preparations and some are made in the form of a mixture of chicken feed. They do not process corn into other processed products that have added value to corn products due to a lackof knowledge to process corn into commercially processed products and other factors becausecorn processing still requires additional costs. These are interviews with old farmers:

> *My wife makes corn for local food (milusiram), for family consumption and also for sale…I don't make other products due to a lack of knowledge and still needmore money (AR, Corn and Coconut Farmer, number 1).*
>
> *I sell most of it to factories, and some of it I make for mixed animal feed becauseI have a chicken coop, it's good enough to save on feed costs (YH, Corn Farmer, number 12).*

Young farmers have several innovations in processed corn including corn flour, corn pie, corn sticks, corn pastels, and corn starch. This corn processing innovation is obtained from interaction with several parties through training and seminars. These are the interviews with young farmers.

> *I made corn flour after receiving training from several agencies such as Koperindag, banking, and universities. I started to open a business using corn ingredients such as corn pie, corn sticks, and corn pastels (JF, Corn Farmer, number15).*
>
> *This corn business came from my parents who still used traditional equipment. Currently, I have used electric tools and machines so that in one day I can produce 30*

kg (RD, Corn Farmer, number 3).

The social network of innovation of old farmers and young farmers in the processing aspect of corn farming can be seen in Figure 6. Results showed that old farmers (P1, and P12) have not innovated because corn is still processed in the form of local food and is used as a mixture of chicken feed, while young farmers (P3 and P15) innovate in processing corn into other processed products with commercial added value to increase income. Processed corn products can be in the form of corn flour, corn sticks, and corn pie.

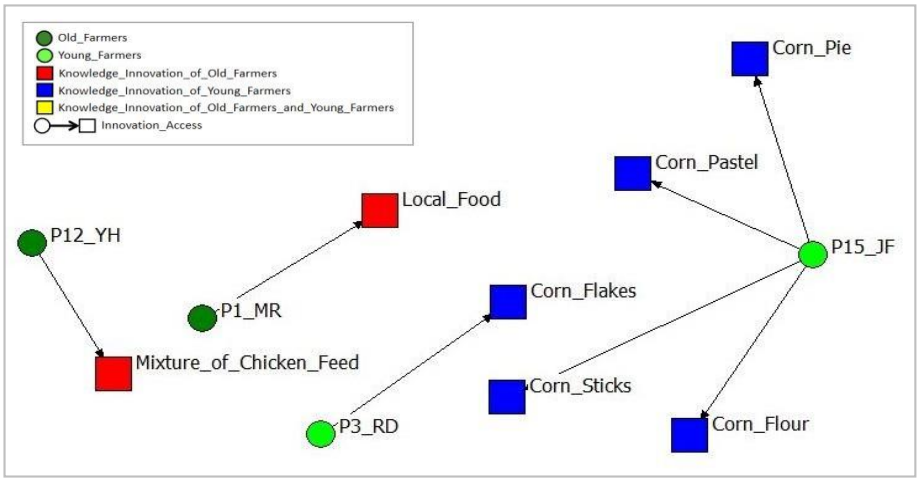


Figure 6. Social Network on Innovation of Old Farmers and Young Farmersin Processing Aspect of Corn Farming

Social Network on Marketing Innovation of Corn Farming

Innovation in the marketing aspect between old farmers and young farmers had differences. Old farmers market corn to traders who usually buy corn by visiting farmers during the harvest season or selling corn through group leaders who already have a marketing network to corn factories. These are interviews with old farmers:

I sell corn to collectors who have been my customers for a long time, usually, they buy corn directly from the field during the harvest season (AH, Corn Farmer, number 7).

We as members of a farmer group sell our crops through the head of the farmer group to the corn factory, so we only enjoy the results of the sale, but sometimes we also sell through the existing WhatsApp group (NH, Corn and Coconut Farmer, number 11).

Young farmers have innovations in marketing the corn by sending samples to corn factories such as in Makassar or Surabaya, because the price is higher than in Gorontalo, as well as doing a taste test. These are interviews with young farmers:

I sent samples of corn to factories in Makassar and Surabaya to get a higher price than in Gorontalo with a price difference of Rp. 150-200 per kg (SL, Corn Farmer, number 21).

I did a consumer taste test for marketing the pie corn to 3 regions, namely Gorontalo, Makassar, and Manado, from this test, I could tell that Gorontalo people generally like chocolate-flavoured corn pie, Makassar people like green bean-flavoured corn pie, and Manado people taste cheese-flavoured corn pie (JF, Corn Farmer, number 15).

The social network on the innovation of old farmers and young farmers in the marketing aspect of corn farming can be seen in Figure 7. Old farmers (P7, and P11) market corn by collecting traders and farmer group leaders, while young farmers (P15 and P21) have innovations in marketing corn by doing a taste test to find out consumer tastes and sending corn samples to companies outside Gorontalo.

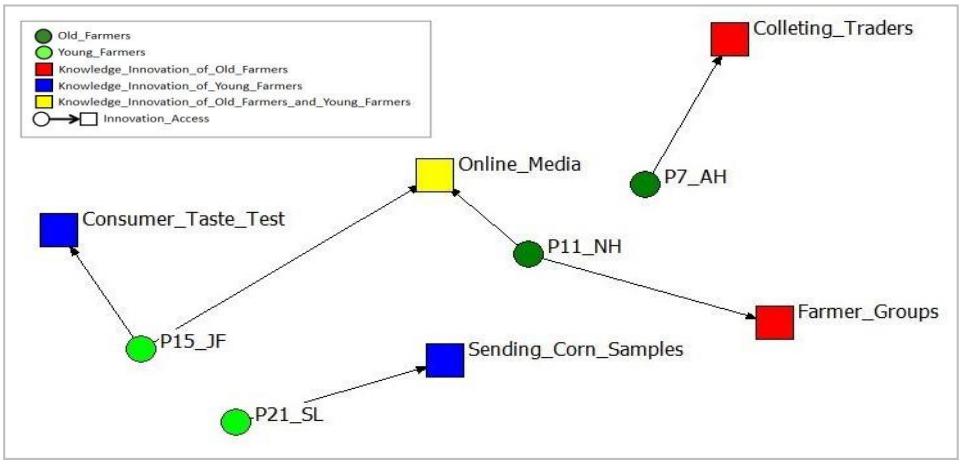


Figure 7. Social Network on Innovation of Old Farmers and Young Farmers in Marketing Aspect of Corn Farming

Based on data from the Gorontalo Provincial Agriculture Office cited by NSLC, (2018), farmers' corn marketing in Gorontalo is commonly through traders in the sub-district capital, wholesalers, and the feed industry. In the research location, there were 36 sub-district traders, 7 animal feed industries, and 4 wholesalers. Traders in the sub-district possess a marketing strategy as fertilizers and agricultural inputs traders who have access to farmer groups in rural areas, wholesalers, and the feed industry. Sub-district traders have technology and facilities such as drying tanks, transport trucks, moisture gauges, and dryers. Wholesalers and the feed industry have modern technologies such as large-scale dryers, warehouses, container trucks, and drying floors. The market price of farmers' corn purchased by traders is IDR 2,750/kg with a moisture content of 23% and IDR 2,950/kg with a moisture content of 17%. Wholesalers and the feed industry purchase corn from farmers and traders for IDR 3,150-3,550/kg with a moisture content of 14%. The application of corn water quality standards from traders, wholesalers, and the feed industry has influenced the farmers' behavior in the utilization of superior seed variety technology, and balanced fertilization spacing in the aspects of corn farming. This is in line with the research findings of research by Jamil et al., (2018), that the success factor in applying technology in producing quality farmer products is the availability of capital, the utilization of superior seed varieties, setting spacing according to plant population, balanced fertilization according to recommendations and intensity counseling. Utilization of technology in harvest and postharvest aspects, such as corn thresher/sheller and dryer to meet corn quality and quality standards. The use of simple corn sheller technology has increased the percentage increase in corn production by 20% or 300 kg/ hour in the corn sorting process, while the use of drying machine technology will dry shelled corn with a moisture content below 30% at a drying speed of 4% per/hour and a temperature drying 65o C (Kevin et al., 2022; Ijah et al., 2021).

Another consequence of the technology application is based on research findings from Hunowu et al., (2021), that changes in farmer behavior regarding the use of technology and significant investments result in farmers paying investors with a high-cost for labor and the use of technology for agricultural production facilities.

The difference in innovation between old farmers and young farmers is due to the lackof knowledge in cultivation and product processing, limited access to information on knowledge sources and information media, especially corn processing and marketing, as wellas lack of access to policymakers in the government sector to manage technology equipment for corn cultivation and processing. According to Ramirez (2013) in addition to gaining knowledge through kinship, farmers must have access to innovation externally that has a different social network for the adoption of technological innovations to occur. The existenceof access to innovation with other actors is revealed in a study by Dolinska & d'Aquino (2016) approach to access innovation in social networks will connect farmers with other actors in the learning process to increase knowledge. The relationship between the social network of innovation between old farmers and young farmers is in accordance with the results of research conclusions from Tolinggi et al., (2023) occurs because there is an attachment between old farmers and young farmers.

Knowledge Sources, Innovation, Corn Ecological Sustainability

Knowledge sources and innovation between old farmers and young farmers have differences in cultivation, processing, and marketing aspects. Knowledge sources, networks and social relations of farmers in corn farming are the difference in producing agricultural productivity. **T**he characteristics of corn farming's cultivation, processing, and marketing are different according to the sources of information and innovation networks of elderly farmers and young farmers. Agricultural production differences are produced by variations in the sources of knowledge, networks, and social relationships generated by farmers in corn farming activities. The ecological

sustainability of farmers' corn farming is based on the knowledge and innovation activities of farmers that they carry out to maintain the sustainability of agricultural practices. This can be viewed in the interview of old and young corn farming farmers below.

I produce my own organic fertilizer for my property, some of which I sell. My objective is to utilize organic fertilizers to improve soil fertility… (SA, corn farmer, informant number 23).

I haven't applied organic fertilization yet, but I'm still using a combination of organic and non-organic fertilizers to maintain corn production in the field. However, I have started to reduce the dosage of using non-organic fertilizers,thus, production input costs have started to decrease by about 30% each planting season... (DB, corn farmer, informant number, 11).

I use an ox plow for tillage so that the soil remains loose, since the majority of farmers in this village currently use the TOT (No Tillage) system, the land is sprayed with herbicides then directly planting the corn (YL, corn farmer, informant number 22)

I have been farming corn for approximately 40 years, and until the present day I still plant local varieties, namely momala and baby corn (Binthe kiki) which are usually grown by my parents and are superior in disease and hot climates resistance… probably as a result of their suitability for the Gorontalo climate (UH, corn farmer, informant number 19)

The prevalent pests at this location are green caterpillars and the disease is leaf blight, which locals refer to as tabongo. In order to prevent the spreads, I naturally spray it with soapy water or tobacco and remove leaf-blighted corn plants from the field (HS, farmer corn, informant number 24)

The land in this village is generally on slopes, thus, the farmer plant by polyculture by integrating corn with plantation crops such as cocoa and candlenut. I created a terraced system to prevent landslides (LD, cocoa and corn farmer, informant number 26).

I have planted corn since the Agropolitan program under Mr. Fadel Governor. I rotated corn and peanuts to avoid pests and diseases (OP, corn farmer, informant number 4).

I made a natural pesticide, i.e., Coryne Bactery, from boiled water of potatoes mixed with sugar which was fermented for 14 days and mixed with bacteria provided by the Horticulture and Plantation Plant Protection Agency (BPTHP), while making my own fertilizer, the bacteria are obtained from nature such as bamboo roots and mimosa roots (Putri malu) then mixed with rice bran water which was fermented for 14 days, we used pesticides and organic fertilizers on corn and vegetable crops (RML, corn and vegetable farmers, informant number 20).

Based on interview results with the old and young corn farmers, some of their efforts are in preserving the ecological sustainability of corn. Old farmers generally carry out activities for tillage by using conventional plows and organic fertilizers to maintain soil fertility, employing local varieties. These old farmers made efforts are to increase the soil fertility of corn plants on dry land with green compost fertilization technology, traditional tillage using reared livestock, and the use of local traditional seed varieties that dry-climates tolerant (Idham et al., 2021; Keban et al., 2019; Chutia dan Borah, 2012). Young farmers use integrated pest management, which includes crop rotation, the production of natural pesticides and herbicides using natural microorganisms, and the prevention of soil erosion by creating terracing combined with polyculture systems planting on land with a slope of more than 15 degrees. This is in accordance with the research findings by Patel et al., (2020), that traditional agricultural practices, such as locally accessible biological pest control methods, crop diversification, and terraced systems, possess the potential to lessen the adverse effects of climate change. In general, the system of ecological sustainability between old and young farmers in corn farming occurs because their social network contributes to access to information and innovation. This social network serves as necessary social capital in the livelihood systems since access relies on social relations (Salman et al., 2021). Based on the findings of Mwangi et al., (2020), that farmers' access to social relations through an innovation system approach from various stakeholders is a process to promote and expand knowledge sharing and interactive learning.

Collaboration of knowledge sources and social networks of old farmers and young farmers is interesting, where the potential between generations can combine local and traditional knowledge that regenerates from generation to generation with modern knowledge based on technological innovation using information media to ensure the sustainability of corn ecologyas a social identity in Gorontalo. Traditional and modern knowledge must be integrated (Šūmane *et*

al., 2018) found that the potential for local traditional knowledge will be optimal through integration with various types of knowledge and multi-actor social networks so that exchanges and knowledge sharing occur in the innovation process. The diversity of knowledge sources and information in social networks will play a big role in the use of technological innovations for farmers (Vishnu et al., 2019). Based on the description above, the grounded theory framework in this study has a relationship between concepts, specifically access to innovation as causal, where social networks are the source of interaction for innovation, and ecological sustainability of corn as a consequence.

Conclusion

There were differences in social networks on knowledge sources between old farmers and young farmers in the cultivation, processing, and marketing aspects. Old farmers use local knowledge sourced from previous generations combined with knowledge obtained from interactions in farmer groups and agricultural extension workers, while young farmers with knowledge come from various actors and different institutions including agricultural extension workers, BPTP researchers, Food Office, Koperindag, Universities, extension workers agriculture, online media (YouTube and Whatsapp groups), banks, seed and fertilizer distributors, associations, SMEs, and corn marketing companies outside Gorontalo, in addition, young farmers also used online media (YouTube, WhatsApp group) as knowledge sources. The difference in innovation between old farmers and young farmers is due to the lack of innovation in cultivation and product processing, limited access to knowledge sources and information media, especially corn processing and marketing, as well as lack of access to policymakers in the regional government sector managing corn cultivation and processing technology equipment. Another finding in this study is that the ecological sustainability of old farmers' corn farming is generally by carrying out activities for tillage using conventional plows and organic fertilizers

to maintain soil fertility and utilizing local varieties. While young farmers practice integrated pest control with crop rotation and the production of natural pesticides and herbicides from natural microorganisms to prevent soil erosion by terracing. In general, the ecological sustainability system between old and young farmers in corn farming activities occurs because their social network contributes to accessing knowledge and innovation in carrying out their farming activities. The policy implications of this research are to submit recommendations to local governments to establish centers of knowledge such as Agro Techno Park, specifically corn commodities. This center aims to collaborate on developing relevant technology by utilizing information sources from the government, industry, universities, and the community in producing appropriate technology.

References

Arifah, Salman D, Yassi A, D. E. (2023). Liveihood System Vulnerability And Knowledge Co-Production Climate Change Adaptation For Rice Farmers In The Bulukumba Regency. Disertasi.Universitas Hasanuddin, Makassar

Bertolozzi-Caredio, D., Bardaji, I., Coopmans, I., Soriano, B., & Garrido, A. (2020). Key steps and dynamics of family farm succession in marginal extensive livestock farming. *Journal of Rural Studies*, *76*(March), 131–141. https://doi.org/10.1016/j.jrurstud.2020.04.030

Chutia, J., & Borah, S. P. (2012). Water Stress Effects on Leaf Growth and Chlorophyll Content but Not the Grain Yield in Traditional Rice (<i>Oryza sativa</i> Linn.) Genotypes of Assam, India II. Protein and Proline Status in Seedlings under PEG Induced Water Stress. *American Journal of Plant Sciences*, *03*(07), 971–980. https://doi.org/10.4236/ajps.2012.37115

Cofré-Bravo, G., Klerkx, L., & Engler, A. (2019). Combinations of bonding, bridging, and linking social capital for farm innovation: How farmers configure different support networks. *Journal of Rural Studies*, *69*, 53–64. https://doi.org/10.1016/j.jrurstud.2019.04.004

Corbin, J. M., & Strauss, A. (1990). Grounded theory research: Procedures, canons, and evaluative criteria. *Qualitative Sociology*, *13*(1), 3–21. https://doi.org/10.1007/BF00988593

Dolinska, A., & d'Aquino, P. (2016). Farmers as agents in innovation systems. Empowering farmers for innovation through communities of practice. *Agricultural Systems*, *142*, 122–130. https://doi.org/10.1016/j.agsy.2015.11.009

Garforth, C., Angell, B., Archer, J., & Green, K. (2003). Improving Farmers' Access to Advice on Land Management: Lessons from Case Studies in Developed Countries. *The Agricultural and Extension Network*, *125*, 1–24.

Hilkens, A., Reid, J. I., Klerkx, L., & Gray, D. I. (2018). Money talk: How relations between farmers and advisors around financial management are shaped. *Journal of Rural Studies*,

63(February), 83–95. https://doi.org/10.1016/j.jrurstud.2018.09.002

Hunowu, M. A., Tamu, Y., Obie, M., & Pakuna, H. B. (2021). Modernization and Shifting Practices of Local Wisdom on Corn Farming in Gorontalo Province. *Sodality: Jurnal Sosiologi Pedesaan*, *09*(02), 1–15.

Idham, I., Pagiu, S., Lasmini, S. A., & Nasir, B. H. (2021). Effect of doses of green manure from different sources on growth and yield of maize in Dryland. *International Journal of Design and Nature and Ecodynamics*, *16*(1), 61–67. https://doi.org/10.18280/ijdne.160108

Ijah, A. A., Olagunju, O. E., Adamu, S. M., Ozoani, H. C., & Rasheed, F. M. (2021). *Development of a Corn Drying System*. *20*(11), 74–79. https://doi.org/10.9734/JERR/2021/v20i1117408

Jamil, M. H., Musa, Y., Tenriawaru, A. N., & Rahayu, N. E. (2018). The innovative characteristics and obstruction of technology adoption for management of integrated plants (PTT) of corn in Gowa Regency Indonesia. *IOP Conference Series: Earth and Environmental Science*, *157*(1). https://doi.org/10.1088/1755-1315/157/1/012054

Keban, A., Lalus, M. F., & Sogen, J. G. (2019). Strategy for Increasing Farmers' Income Through Dry Land Resources Combination in Kupang District of Nusa Tenggara Timur. *Russian Journal of Agricultural and Socio-Economic Sciences*, *91*(7), 349–357. https://doi.org/10.18551/rjoas.2019-07.41

Kevin, R., Naufal, A. N., & Hanifah, A. P. (2022). *Corn Sheller Machine Technology To Improve Farmers ' Productivity*. *17*(3), 1697–1707.

Klerkx, L., Schut, M., Leeuwis, C., & Kilelu, C. (2012). Advances in knowledge brokering in the agricultural sector: Towards innovation system facilitation. *IDS Bulletin*, *43*(5), 53–60. https://doi.org/10.1111/j.1759-5436.2012.00363.x

Lwoga, E. T., Ngulube, P., & Stilwell, C. (2010). Managing indigenous knowledge for sustainable agricultural development in developing countries: Knowledge management approaches in the social context. *International Information and Library Review*, *42*(3), 174–185. https://doi.org/10.1016/j.iilr.2010.07.006

Mc Fadden, T. (2016). A description of data sets to determine the innovative diversification capacity of farm households. *Data in Brief*, *8*, 1088–1093. https://doi.org/10.1016/j.dib.2016.07.007

Mills, J., Reed, M., Skaalsveen, K., & Ingram, J. (2019). The use of Twitter for knowledge exchange on sustainable soil management. *Soil Use and Management*, *35*(1), 195–203. https://doi.org/10.1111/sum.12485

Mwangi, M., Kituyi, E., & Ouma, G. (2020). Enhancing adoption of climate services through an innovation systems approach. *Scientific African*, *8*, e00445. https://doi.org/10.1016/j.sciaf.2020.e00445

NSLC. (2018). *Komoditas jagung provinsi gorontalo*.

Patel, S. K., Sharma, A., & Singh, G. S. (2020). Traditional agricultural practices in India: an approach for environmental sustainability and food security. *Energy, Ecology and Environment*, *5*(4), 253–271. https://doi.org/10.1007/s40974-020-00158-2

Ramirez, A. (2013). The Influence of Social Networks on Agricultural Technology Adoption. *Procedia - Social and Behavioral Sciences*, *79*, 101–116. https://doi.org/10.1016/j.sbspro.2013.05.059

Ribot, J. C., & Peluso, N. L. (2003). A theory of access. *Rural Sociology*, *68*(2), 153–181. https://doi.org/10.1111/j.1549-0831.2003.tb00133.x

Salman, D., Kasim, K., Ahmad, A., & Sirimorok, N. (2021). Combination of bonding, bridging and linking social capital in a livelihood system: Nomadic duck herders amid the covid-19 pandemic in South Sulawesi, Indonesia. *Forest and Society*, *5*(1), 136–158. https://doi.org/10.24259/fs.v5i1.11813

Skaalsveen, K., Ingram, J., & Urquhart, J. (2020). The role of farmers' social networks in the implementation of no-till farming practices. *Agricultural Systems*, *181*.

https://doi.org/10.1016/j.agsy.2020.102824

Spielman, D. J., Davis, K., Negash, M., & Ayele, G. (2011). Rural innovation systems and networks: Findings from a study of Ethiopian smallholders. *Agriculture and Human Values*, *28*(2), 195–212. https://doi.org/10.1007/s10460-010-9273-y

Šūmane, S., Kunda, I., Knickel, K., Strauss, A., Tisenkopfs, T., Rios, I. des I., Rivera, M., Chebach, T., & Ashkenazy, A. (2018). Local and farmers' knowledge matters! How integrating informal and formal knowledge enhances sustainable and resilient agriculture. *Journal of Rural Studies*, *59*, 232–241. https://doi.org/10.1016/j.jrurstud.2017.01.020

Sumarno, J., & Hiola, F. S. I. (2017). Faktor Sosial Ekonomi Yang Mempengaruhi Adopsi Pengelolaan Tanaman Terpadu (Ptt) Jagung Di Gorontalo. *Informatika Pertanian*, *26*(2), 99. https://doi.org/10.21082/ip.v26n2.2017.p99-110

Thomas, E., Riley, M., & Spees, J. (2020). Knowledge flows: Farmers' social relations and knowledge sharing practices in 'Catchment Sensitive Farming.' *Land Use Policy*, *90*. https://doi.org/10.1016/j.landusepol.2019.104254

Tolinggi, W. K., Salman, D., & Iswoyo, H. (2023). *Farmer regeneration and knowledge co - creation in the sustainability of coconut agribusiness in*.

Tsouvalis, J., Seymour, S., & Watkins, C. (2000). Exploring knowledge-cultures: Precision farming, yield mapping, and the expert - farmer interface. *Environment and Planning A*, *32*(5), 909–924. https://doi.org/10.1068/a32138

Van Rijn, F., Bulte, E., & Adekunle, A. (2012). Social capital and agricultural innovation in Sub-Saharan Africa. *Agricultural Systems*, *108*, 112–122. https://doi.org/10.1016/j.agsy.2011.12.003

Vishnu, S., Gupta, J., & Subash, S. P. (2019). Social network structures among the livestock farmers vis a vis calcium supplement technology. *Information Processing in Agriculture*, *6*(1), 170–182. https://doi.org/10.1016/j.inpa.2018.07.006

Wójcik, M., Jeziorska-Biel, P., & Czapiewski, K. (2019). Between words: A generational discussion about farming knowledge sources. *Journal of Rural Studies*, *67*(February), 130–141. https://doi.org/10.1016/j.jrurstud.2019.02.024

Wood, B. A., Blair, H. T., Gray, D. I., Kemp, P. D., Kenyon, P. R., Morris, S. T., & Sewell, A. M. (2014). Agricultural science in the wild: A social network analysis of farmer knowledge exchange. *PLoS ONE*, *9*(8). https://doi.org/10.1371/journal.pone.0105203

Appendix: Profile of Research Informant Characteristics

Socioeconomic Characteristics of Corn Farmers Research Sample

No/farmers initial	Farmer Generation Category		Land area (acres)	Education Level	Farming/processing experience (years)	Activity Category			Interview Duration (minute)
	Young 20-45 years	Old 46-65 years				Cultivation	Processing	Marketing Purpose	
1. YP	-	60	2	Elementary School	30	Corn and coconut	Peeled corn	Trader	75
2. AH	-	50	10	Junior High School	15	Corn and coconut	Peeled corn	Factory	30
3. OP	-	51	1	Junior High School	19	Corn	Peeled corn	Factory	35
4. AM	-	48	3	Senior High School	7	Corn	Peeled corn	Factory	30
5. MG	44	-	2	Junior High School	11	Corn	Peeled corn	Factory	25
6. AW	43	-	10	Senior High School	25	Corn	Peeled corn	Factory outside region	65
7. YL		70	4	Elementary School	22	Corn	Peeled corn	Factory	35
8. MP	45	-	1	Senior High School	10	Corn	Corn Sticks	Supermarket	20
9. JF	44	-	2	Senior High School	12	Corn	Corn pie, corn flour	Supermarket, market outside region	60
10.MD	29	-	1	Bachelor	5	Corn	Corn pie, corn sticks	Store, Supermarket	45
11.UH	-	60	2	Elementary School	30	Corn	Peeled corn	Trader	25
12.SM	-	69	1	Junior High School	38	Corn	Peeled corn	Factory, traders	30
13. YH	-	59	2	Junior High School	29	Corn	Peeled corn	Trader	30
14.AW	43	-	10	Senior High School	25	Corn	Peeled corn, animal feed	Traditional market outside region	65
15.SM	-	69	1	Elementary School	38	Corn and coconut	Peeled corn	Trader	30
16.AK	-	54	2	Junior High School	21	Corn	Peeled corn	Factory, trader	35
17.SD	39	-	5	Bachelor	12	Corn and coconut	Peeled corn	Factory	25
18.MA	-	55	5	Senior	20	Coconut	Copra,	Factory,	30

				High School			**seed grower, fresh fruit**	**trader, farmer**	
19.AR	**-**	**52**	**2**	**Elementary School**	**30**	**Corn and coconut**	**Peeled corn**	**Trader**	**30**
20.RD	**43**	**-**	**1**	**Senior High School**	**9**	**Corn**	***Bepang* corn**	**Traditional Market**	**45**
21.NH	**29**	**-**	**1**	**Bachelor**	**15**	**Coconut, corn**		**Factory, trader**	**45**
22.SL	**42**	**-**	**8**	**Senior High School**	**44**	**Corn**	**Peeled corn**	**Factory outside region**	**30**
23.SA	**42**	**-**	**3**	**Bachelor**	**20**	**Coconut, corn**	**Peeled corn**	**Factory**	**75**
24.DB	**44**	**-**	**1**	**Senior High School**	**11**	**Corn**	**Flour dan corn pie**	**Factory, local and broad traditional markets**	**40**
25.LD	**42**	**-**	**2**	**Senior High School**	**8**	**Corn**	**Peeled corn**	**Factory**	**75**
26.RML	**40**	**-**	**2**	**Senior High School**	**10**	**Corn, horticulture**	**Peeled corn**	**Factory**	**65**

Research Article

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Abstract: Farmer regeneration in agribusiness sustainability originates from the innovation of knowledge co-creation among farmer generations and interaction between stakeholders within and outside local contexts. The present work aims at exploring knowledge co-creation in the context of different orientations between young and old farmers. It also seeks to characterize the orientation of the two farmer groups from the aspect of agriculture, processing, and marketing of coconut through knowledge co-creation interaction to further their agricultural activities. All data in this grounded theory research came from in-depth interviews; the data were further examined using an open, axial, and selective coding method. The transcription of the field note was analyzed using an ATLAS.ti version 9, a program for analyzing qualitative data. The sample of the study was 13 of young farmers (25 to 45 years old) and 17 of old farmers (45 to 65 years old). The results revealed that the old farmers focused on revitalizing coconut trees for long-term purposes. The knowledge co-creation process among this farmer group (with other stakeholders) put an emphasis on copra and cooking oil production. Young farmers, however, focused on coconut tree integration with annual plants for short-term purposes, especially on the virgin coconut oil and innovative products from foreign technology adaptation. In conclusion, coconut business sustainability is the byproduct of knowledge co-creation and engagement between old and young farmers. This condition results in the survivability of coconut farmers. The novelty of this study lies in the classification of the orientation of the two coconut farmer groups in terms of agricultural, processing, and marketing aspects, which results in knowledge co-creation and its relation to the sustainability of coconut agriculture.

Keywords: between generations, new peasant, coconut farming

1 Introduction

The model of the peasantry is known as the appearance of a new generation of farmers who continue to struggle-autonomy, including coaching, maintenance, and courtesy resource-based with self-driven narratives of experience and knowledge [1]. It is worth noting that the term autonomy, in this concept, does not refer to production in a balanced situation. Rather, such a concept is depicted as an entrepreneurial process that results in distinctive, recognizable, and competitive products [2]. In the entrepreneurial decision by the new peasant generation, knowledge and its sources are essential factors that need to be discussed in the context of farmers' interactions with various stakeholders [3].

Various studies have identified the relationship between knowledge and agricultural practice. Authors of ref. [4] assert that agricultural development is closely related to knowledge change, shared learning, and knowledge co-creation. Authors of refs [5,6] argue that the incorporation between the types of knowledge and shared learning resulting in new knowledge through multi-stakeholder interactions can change the behavior, practices, policies, and institutions. They further add that changes at the farmer level can improve the livelihood system. Authors of ref. [7] state that farmers contribute more to the social and independent learning system than the learning system accessed

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through a formal institution [7]. Still, it is worth noting that little is known regarding the correlation between knowledge development and knowledge co-creation in the farmer regeneration context. The context of farmer regeneration is of paramount importance in the study of knowledge co-creation due to differences in perceptions about employment in the agricultural sector between old farmers (who consider agriculture to be an occupation for low social strata) and young farmers (who perceive agricultural occupation as an opportunity, especially if they can take advantage of information) [8]. The present work is similar to previous studies in terms of the exploration of farmers' interaction that creates knowledge co-creation. The difference between this research and the previous studies lies in the identification of behavior orientation between old farmers and young farmers and the sustainability of coconut farming due to the interrelation between the two farmer groups in the cultivation, process, and marketing of coconut products. This interrelation between the farmer groups leads to knowledge co-creation that is central to coconut farming sustainability. Determining the research participants (old farmers and young farmers) was challenging, especially in collecting data from the interview. The challenge was due to the disparity in knowledge and experience between the two farmer groups, resulting in the inability of the subjects to provide information relevant to the research theme. Furthermore, the restriction due to the covid-19 pandemic hindered the author from meeting the informants in person. As a result, phone interview sessions were performed, where all information was recorded and transcribed. Several key actors and facilitators involved in mentoring programs were also interviewed, including representatives from Central Bank of Indonesia Gorontalo Representative, the Agricultural Technology Assessment Agency (BPTP) of Gorontalo, and the National Support For Local Investment (NSLIC) program. Researchers from universities investigating coconut and other themes related to the theme of the present work were also involved as the informant.

In Indonesia, coconut farming is unique since the expansion of oil palm as a source of cooking oil does not affect the coconut business. Many have produced diversified products, such as virgin coconut oil. This condition confirms innovation through knowledge co-creation between coconut farmers, such as in Gorontalo, Indonesia. In this province, the coconut plantation area increased to 68.975 in 2020 from 67.495 in 2018 [9]. The production of coconut commodities also saw a rise to 57.974 in 2020 from 55.946 in 2018 [10]. This confirms that local communities in the province favor coconut. This condition resonates with the results of NSLIC [11] confirming that coconut is the primary commodity mostly grown by many farmers. Some grow coconut using a monoculture approach, while others incorporate other crops in the cultivation. NSLIC [11] estimates the population of coconut farmers in Gorontalo Province as 55,552 individuals; the majority of farmers are in Gorontalo regency and Pohuwato regency.

Knowledge co-creation, in this study, is defined as the interaction between scientific knowledge and public knowledge in which novelty emerges as a result of a shared evolutionary process [12,13]. Lying within this process is the interconnection between knowledge and decision-making [14]. Knowledge co-creation can also be defined as a repetitive and collaborative process involving expertise and actors in formulating specific knowledge for sustainable systems [15]. The process incorporates a mechanism of uniting ideas from different actors to come up with innovative solutions [16]. Knowledge co-creation between fellow farmers or between farmers and other parties occurs due to farmers' interaction with technology developers, including experiments based on farmers' experience [17–19].

This research discusses knowledge co-creation in the context of different orientations between new and old farmers. Further, this research also aims to characterize the orientation of the two farmer groups from agriculture, processing, and marketing of coconut. Knowledge co-creation among young farmers, old farmers, and both are also explored. Following the research method section below is the finding explaining the difference between the orientation of old farmers and young farmers, and the co-creation processes involving these two farmer groups.

Constructing field contexts and phenomena related to the research topic is a rigorous task, particularly in producing action-oriented categorizations and interactions between old farmers and young farmers in producing knowledge co-creation. This is because of the different characteristics of the two farmer groups, involving age, land area, farming experience, and cosmopolitan aspect. This difference becomes one of the research gaps that need to be addressed, i.e., whether the new knowledge co-creation resulted from the interaction and engagement of old farmers and young farmers or other external factors' influence. On that ground, this study aims to address the gap in the literature by identifying and categorizing action orientations between old and young farmers in several aspects, such as cultivation, process, and marketing of coconut farming. The dynamics and structural factors in old farmers and young farmers are also contributing factors to knowledge co-creation.

2 Materials and methods

This qualitative research employed a grounded theory method. The reason for selecting this method is to formulate a general and abstract theory based on processes, actions, or interactions in social reality [20].

The sample involved coconut farmers with business scopes in cultivation, processing, and marketing. In categorizing the farmers, the present work applied a model by Statistics Indonesia: old farmers are aged 46–65 years and young farmers involve individuals aged 25–45 years. All samples were from nine districts in Gorontalo regency, i.e., Telaga Biru, Limboto, Limboto Barat, Tibawa, Pulubala, Bongomeme, Dungaleya, Tabongo, and Batudaa (Map 1) (Figure 1).

The data were analyzed using open, axial, and selective coding as Corbin and Strauss [20] proposed. Fragments from interviews related to the research focus were selected in the open coding. These fragments were coded based on the relevant concept. Following the open coding was the axial coding in producing a specific category. Bertolozzi-Caredio et al. [21] defined axial coding as a step of processing open coding outputs through deletion, purification, and integration of open coding outputs, resulting in more comprehensive and meaningful data. In axial coding, a category is linked with sub-categories and tested with data before building relationships between the categories [20]. The accuracy of the sub-categories is checked by locking the relevant statements with the sub-categories for the sample [22]. Selective coding was conducted by utilizing the output of axial coding. Further, the relationship between categories was built according to the focus of the research.

Observations and interviews were conducted from April to September 2021, involving 43 coconut farmers. Information from observations and unstructured interviews was then transcribed. Following the process was the coding phase to extract categories from the transcription of field note data. Axial coding was also performed to identify the relation between the category. The core categories were identified and described in the third phase, selective coding [23]. This process identified 30 farmers with statements relevant to the research topic. Field note data and transcripts of 30 farmers were examined through interviews to confirm information related to the problems and research objectives. As many as 17 old farmers and 13 young farmers involved in the cultivation, process, and marketing of coconut farming were interviewed. They were selected after the data were considered saturated, i.e., where no new information is obtained from the sample during the interview [24]. In the interview, open questions were asked before proceeding to structured questions as based on the research topic; the interview took 30–75 min. Furthermore, all answers from the participants were recorded and transcribed.

Interview data included transcripts of field notes, video recordings, audio, media news, expert statements,

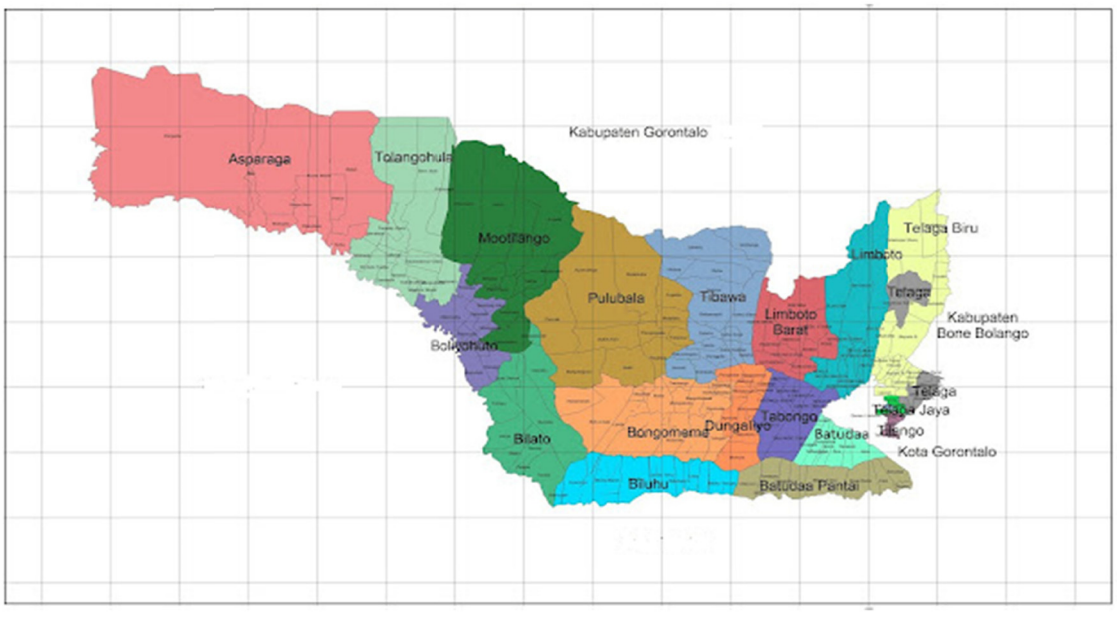

Figure 1: Research site map (source: http://www.disdukcapil-gorontalokab.web.id).

articles, and books. All data were processed using the ATLAS.ti qualitative data analysis software version 9. This application aims to help with the coding of the transcription of field notes [25].

Informed consent: Informed consent has been obtained from all individuals included in this study.

3 Results

This study successfully identifies the difference in orientation between old farmers and young farmers in coconut agribusiness; the orientation covers three aspects, i.e., cultivation, product processing, and marketing. All characterizations of the orientation of the two farmer groups are displayed in Table 1.

3.1 Orientation differences between old farmers and young farmers

3.1.1 Cultivation

Old farmers, in sustaining their coconut cultivation, apply the concept of long-term orientation, i.e., performing rejuvenation processes to 40–50-year old trees that are less productive. According to the interview, the farmers prefer to stick with maintaining their coconut tree population, in terms of the land area and the production. This is done through removing the old, unproductive tree, selecting coconut seedlings, and pest management; see interview excerpts below.

"I go with rejuvenation through removing unproductive trees to maintain tree population, because most of the trees have been planted since long ago by my parents." AH, Farmer 7

"I use seedlings from the same broodstock in rejuvenating "kelapa dalam" (a local variety of coconut) and keeping the seedlings in a nursery (open space) for one month to select quality coconut seeds." MH, Farmer 21

"Beetles are the common coconut pest. I use traditional formula. I mix tobacco, betel leaves, pepper, and salt into water and boil these materials. I separate the water before applying the formula to the trees that have been attacked." YP, Farmer 26

Young farmers have different perspective in coconut cultivation compared to old farmers. They optimize their planting area by cultivating other commodities, such as maize, peanut, and chili, as intercrops (they plant it under coconut trees) to earn extra income. In cultivation aspects, young farmers opt to remove the upper part of coconut fruit to optimize the growth of the sprout. They prefer insecticide in combatting beetle; this is performed when the coconut is 1–2 years of age. Below are interview excerpts regarding the orientation of young farmers regarding coconut cultivation.

Table 1: Characteristics of orientation of old farmers and young farmers in coconut agribusiness

Aspects of coconut Farming Management	Orientation Pattern	
	Old farmer	**Young farmer**
Coconut farming	Cutting and removal of old, senile, unproductive, and disease-advanced trees to maintain the tree population and crop productivity	In addition to cutting and removing the unproductive trees, other commodities were planted in between the coconut trees to earn additional income
	The selection of quality seedlings is performed by putting down the seed-nut in a nursery	The selection of seedlings is performed by removing the upper part of the coconut seed to allow the sprout growth
	Pest control processes rely on local pesticides and traditional techniques	Pest control processes are performed by spraying insecticides
Crop processing	Relying on mainstream crop processing (i.e., methods that have been passed from generation); the products involve conventional copra, shell charcoal, and coconut oil	Creating innovative product, e.g., virgin coconut oil (VCO), white copra, briquette, soap, traditional coconut oil (processed using advanced technology)
Product marketing	Relying on the existing copra market chain through distributing the product to the collecting traders in the village; the fresh coconut fruits are distributed to the manufacturers	Relying on multiple market chains through coconut small and medium enterprises (SMEs), selling products in coconut fairs, and exporting the coconut

"My coconut grow well after I started planting maize, peanut, and chili. I think this is because of the fertilizer I have used for those crops, which I have planted under the coconut trees. The condition is different from when the land was only planted with coconut." KHM, Farmer 23

"I remove the upper part of the seedlings to help the growth of the sprout." SM, Farmer 22

"Usually, beetles started attacking my coconuts when the crops are 1 to 2-years age. I use insecticide to fight the pests, keeping my coconuts from dying." MD, Farmer 27

3.1.2 Processing

The way young farmers process coconut products differs from that of the old farmers. In general, old farmers process coconuts into oil, copra, and charcoal using traditional methods. They prefer methods that have been passed from generation; see the excerpts below.

"I have been making coconut oil since I was 15. That was when I helped my parent's coconut oil business. I follow the methods that my parents have used in making traditional oil. All cooking tools are traditional. I have used the tools for grating the coconut, squeezing the coconut milk, cooking the coconut milk until it separates, and filters the coconut oil and water." RM, Coconut Cooking Oil Maker, Participant 3

"I have been planting coconut in my parent's land since I was 20. The fruits are processed into copra using the traditional roasting tools called "porono" since 2010. The coconuts were putted on the tool after being cut. We use coconut charcoal for the fuel." MM, Farmer, Participant 13

"Other than selling desiccated coconuts to manufacturers, coconuts I peeled using a traditional tool called "pasumbi" are processed into copra. I have two roasting tools (porono); during the roasting process, I don't cover the tool as we rely on sunlight to help fasten the drying process." YK, Coconut Farmer, Participant 10

Young farmers are more creative when it comes to meeting market demands. They process the coconuts into VCO, briquette, cookies, cooking oil, and "dodol" (a sweet toffee-like sugar palm-based confection) made of coconut milk. Based on the notion, it can be said that the young farmers are keen on the opportunity and prospects of coconut products. Interaction with coconut producer association is among the key to obtaining information regarding coconut product commodities in domestic and international markets. Such is evident from the interview transcript below.

"At first, I was interested in making VCO because I often read Trubus (a botanical magazine) 2001 edition. Then, I tried everything I have read, where the VCO product is better than local products. I use coconuts from my plantation and a Sumber Alam, a VCO business group under my supervision, to make VCO. My VCO products have gone through seven-time filtering processes in a night. The processes produce one liter of oil, so it needs patience." AA, VCO producer, Participant 6

Young farmers tend to experiment with a lot of processes, such as adding antioxidant agents, e.g., papaya and turmeric leaves into cooking oils in order to fulfill market demands. This is based on the interview with several producers of cooking oil and VCO.

"Since 2017, I began my coconut oil business using some tools that were not used by uncle. I started to experiment with some ingredients in 2018, such as mixing extracts of papaya and turmeric leaves that contains antioxidant agents. My coconut oil was on the list of pilot project in Gorontalo. I have started making VCO since 2019; I named the product CocoBI or Coconut Buatan Isimu." WK, Coconut Oil and VCO Producer, Participant 16

Some differences are noted in terms of the production aspect between young farmers and old farmers, despite the similarity shared between the two farmers, i.e., both run a family business. In this research, one example is adding coconut milk to "dodol" product as stated by AL, the owner of dodol business.

"My mother has been making dodol on certain occasions, such as Ketupat day (a celebration after the seventh day of Eid al-fitr). She made the snack for the guests, family, and relatives when they visited our house. Some of them bring dodol and "nasi bulu" (rice cooked in bamboo tubes) as a souvenir. Since then, we continue making dodol as a family business." AL, Dodol Business Owner, Participant 17

3.1.3 Marketing

Young farmers and old farmers have differing perspectives in terms of marketing orientation. Old farmers tend to sell their coconut products in the form of copra, charcoal, traditional coconut oil, and coconut fruit to collecting traders in the town or manufacturers. This is based on the interview data.

"I sell my coconut cooking oil in my neighborhood by order. I also distribute it to the nearby market." RM, Coconut Oil Producer, Participant 3

"All of my coconuts are processed into copra. The buyers came to my place when they need the product.

I have been cooperating with some business partners for eight years." MM, Coconut Farmer and Copra Producer, Participant 13

"We harvest the coconut every four months, that is three times a year. We sell the coconut to a nata de coco manufacturer that has been cooperated with us for 5 to 6 years." YK, Coconut Farmer, Participant 10

Young generation of farmers create innovation in marketing their coconut products. They rely on radio advertisement, small and medium enterprises (SMEs), coconut partnership association, and coconut fairs (local and international) through business network they have built when participating in workshops or seminars. This finding is based on the interview transcript below.

"I distribute my VCO product to local market and Surabaya through SMEs association; we support each other in the association. The association offers wide range of coconut products, such as VCO, briquette, traditional coconut oil, soap, charcoal, and white copra. The distribution of the products is managed by the association members depending on the market demand. I also often participate in coconut fairs in Gorontalo, Jakarta, and Surabaya." WK, VCO Producer, Participant 16

"I distribute my product, Sumber Alam VCO, to Papua and Jakarta from 2011 to 2012. In local markets, I sell my products to pharmacies in Gorontalo and I rely on radio advertisement to market my VCO. Even some buyers from India and Malaysia have visited my place." AA, VCO Producer, Participant 6

Cultivation, process, and marketing aspects between the young and old generation of farmers differ from one another. Old farmers focus on coconut rejuvenation and coconut population sustainability to maintain their income. On the other hand, young farmers opt to earn income outside of coconuts by planting seasonal crops as intercrops, including corn, chilies and peanuts. Differences in the orientation of farmers' actions can also be seen in the processing aspect. Old farmers rely on conventional tools that have been used from generation to generation, while young farmers are capable of adjusting themselves with technology advancement, which enables them to produce high economic value products according to market demands, including virgin coconut oil, white copra, coconut flour, coconut milk briquettes, coconut cooking oil, soap, and coconut shell charcoal. This condition occurs since young farmers do not have a choice in rejuvenating coconuts as many coconut plantations are owned by old farmers. The data by BPS Gorontalo Province [10] (not published) confirm the situation mentioned earlier, where old farmers owning coconut land and participating in a coconut rejuvenation program account for 56.49%, and young farmers participating in the program account for 43.15%. Another contributing factor is that the majority of agriculture land is dominated by maize farmers, where the total land area for this commodity is 284824.5 hectare, outnumbering the coconut plantation with just 449 hectare [9].

In marketing aspects, old farmers continue the existing market chain, selling their product to the returning consumers, e.g., collecting traders or manufacturers. Young farmers have multiple approaches in selling their products, relying on their access to the updated information in coconut market. This finding is in accordance with the peasantry model of van der Ploeg [1] regarding the existence of a new peasant generation that autonomously struggles and survives to manage natural resources (in this case coconut land). Similarly, the finding resonates with the results seen in ref. [2], reporting that the new peasant generation exercises autonomy in natural resource management through entrepreneurial which enables it to produce distinctive, recognizable, and competitive products in the market. Conclusion of authors of ref. [2] is in line with the finding seen in ref. [26] in which the orientation of old farmers in Thailand tends to be less innovative and less-productive in agricultural practices. It is due to their reluctance to invest in agriculture and inability to delegate family members to continue their business after retirement. On the other hand, the orientation of young farmers is emphasized more on innovative agricultural practices, involving the investment in capital and the use of technology, e.g., greenhouses with drip irrigation or hydroponic technology.

3.2 Knowledge co-creation between old farmers and young farmers

Processes of knowledge co-creation between two generations of farmers take place due to the interaction of ideas and knowledge, resulting in new knowledge. Other parties are also involved in the information exchange that encompasses agricultural, product process, and marketing aspects to come up with innovation in coconut farming. All ideas and information from the experience of a farmer are then implemented by other farmers. The present work explores the process of knowledge co-creation among old farmers, among young farmers, and between the two farmer generations. Provided in Table 2 is the category of knowledge co-creation process.

Table 2: Knowledge co-creation between old farmers and young farmers in coconut agribusiness

Generation category	Knowledge co-creation characteristics
Among old farmers	Knowledge co-creation is incorporated in removal of unproductive tree, seed planting, and pest management.
Among young farmers	Knowledge co-creation concepts are seen in the variants of coconut products and packaging
Inter-generation	Knowledge co-creation concepts are seen in seed breeding and product processing

3.2.1 Knowledge co-creation among old farmers

Knowledge co-creation among old farmers revolve around their experience or everything they have learned from their parents. This interaction generates new ideas that they implement in their business. Following this process is the discussion of the implementation outcomes. Knowledge co-creation in cultivation aspect is seen from the interview excerpts below.

"I remove the old, unproductive trees for rejuvenation since all my coconuts are above 30 years age. I use "lima dobol" technique, that is replacing the old trees with the new ones, putting the trees between the unproductive trees to get optimum sunlight. Some of farmer peers also apply this method, one of them is Mr. AB (coconut farmer no. 25). We do this process after discussing with each other." YP, coconut farmer no. 26

"I use tobacco water to fight beetle pests; I apply the water to the shoots during noon. I got this method from Mr. YP (farmer no. 26); some farmers in town have also tried the method thanks to the exchange of information we have done." AB, coconut farmer no. 25

3.2.2 Knowledge co-creation among young farmers

Young farmers focus on production and marketing aspect in information exchange. Such interaction results in innovation of new products as seen in the transcript of interview with young farmers below This is seen in the following interview data.

"Other than making VCO, I experiment with some formula in making coconut oil. For example, I add papaya leaves and turmeric extracts into the oil as they contain antioxidant agents. I discuss my experiment in a coconut SME forum. From the discussion, I gain invaluable inputs from my peers, including information of prospective buyers." WK, member of coconut SME association, Participant 16

3.2.3 Knowledge co-creation between old farmers and young farmers

Cultivation, process, and marketing aspects are the topics covered in knowledge co-creation between the young and old generation of farmers. The discussion takes place not only among business people who run a family business, but also those who are new to coconut business. This is based on the interview data as follows:

"I interact a lot and share knowledge with my son, (HH, farmer 20), regarding cutting, a coconut breeding technique, to accelerate shoot growth. I only used the coconut seed breeding technique inherited from my parents." MH, old farmer 21

"There is a difference in the knowledge about captive coconut seeds that I learned from my parents (MH, coconut farmer 21) and the knowledge I got from trainings by the government since I became a partner with the Plantation Service. After learning the technique from my parent, the growth rate rose to 90% and even 95% from 70%. The slicing phase of coconut seedlings will accelerate the growth of shoots." HH, old farmer 20

"In making the VCO, I worked with three groups comprising eight persons each group (old farmers and young farmers). Sumber Alam, our VCO products, are then processed, labelled, and marketed. We have marketed our VCO product to local markets, other provinces, such as Papua and Jakarta, and international markets, such as India and Malaysia." AA, VCO business CEO, farmer 6

"I am a member of the Coconut Processing Association in Gorontalo Province. Currently, the association has 22 members consisting of 15 members aged under 40 years and 9 members aged over 45 years. This SME produces coconut products, such as VCO, boiled coconut oil, coconut shell charcoal, white copra, and soap. We communicate through WhatsApp groups and regular meetings once a week, exchanging information, especially about the market price of processed coconut, buyers, as well as training and exhibitions of coconut processing." WK, VCO SME member, farmer 16

The aforementioned discussion explains the interaction between old farmers and young farmers in exchanging information of coconut processing in a community. Such activities help them produce quality coconut products with a high economic value. Advantages of interaction and knowledge sharing has been deemed impactful to the knowledge co-creation between two different groups in producing quality outputs or products [27]. The interrelation between old farmers and young farmers has been discussed in ref. [28] that reports on the necessity for facilitating the two farmer generations by using methods, tools, and technology, especially in the transfer and sharing of knowledge. One method is creating heterogeneous settings, such as joint interactions and laboratory based, home based, or community based. Establishing partnership between farmers is also needed in improving knowledge for sustainable agricultural development. Authors of ref. [29] provide two actual solutions with an interaction approach that contribute to different values in knowledge value creation: individual farmer–researcher–advisor interaction and interaction with farmer group advisors. The linkage of knowledge transfer in agricultural families has remained central to the agricultural knowledge transfer between generations due to the diversity and intensity of relationships that could establish kinships among farmers [3].

3.3 Barriers and structural factors of old and young farmers, farmer regeneration

Barriers and dynamics between old and young farmers in accessing knowledge are different. When old farmers receive new information on the innovation of coconut processed knowledge, they do not proceed to trials, as they are reluctant to face risks and seek information regarding these innovations through the media and other sources of knowledge. On the other hand, young farmers immediately respond when they receive new information on innovative coconut process by conducting repeated trials and experiments and seeking additional information from several resources, training, technical guidance, and digital media. This is based on the interview data as follows:

"Sharing knowledge and information to old farmers are difficult, they will only listen and observe, not put everything into practice Extension sessions in detail are something they need. Young farmers are quick learners, they do not require extensive training and education, they immediately understand and put everything into practice. They also learn from YouTube." AA, VCO business leader, farmer 6

"When it comes to the interaction and knowledge sharing with young farmers, their response is faster compared to old farmers. Young farmers will apply the knowledge and information immediately, and ask me if there are something they do not understand. This is something I cannot see when sharing with old farmers." MA, leader of burnt copra SME, farmer 31

"My first experience producing VCO from young coconuts was a failure because the processed product didn't turn into VCO. I tried to repeat the second trial, using half-dried coconuts. It turned out that the processed oil was still thick like coconut oil, different from VCO. I tried again the third stage with dry coconut by filtering it for seven times using special cotton, filter cloth. The results were good. I could maintain the results and quality after trying and experimenting for almost six months. I learned success is not an instant process, it takes time and patience." AA, Head of VCO Processing, farmer 6

"Before producing VCO, I did a lot of experiments in making cooking coconut oil; I read a lot of information and browsed from online media (YouTube). One example of my experiment is the addition of papaya leaves as an anti-oxidant, adding more values for my coconut oil. I also added lemon ash to speed up the smoking for the separation of oil and water. In addition, I tried mixing processed coconut with turmeric to have a yellowish color, considering a market segment that favor this type of cooking coconut oil." WK, UKM VCO and traditional cooking oil, farmer 16

The interview data above show that the barriers and dynamics of access to knowledge between old farmers and young farmers occur due to several differences. Some of these include responses in accessing and responding to information and knowledge innovation, media access to knowledge sources, and motivation to conduct repeated experiments and trials. Failure to process coconuts does not dampen the enthusiasm of young farmers to innovate for the success of their farming practices. This notion corresponds to the result seen in a study by Milone and Ventura [2] that the success of young farmers, as entrepreneurs is due to their creativity, innovation, and ability to collaborate in establishing networks with stakeholders outside the agricultural sector and respond to demands and expectations of agriculture and food sectors. The motivation and enthusiasm of young farmers to carry out continuous experiments are in line with the findings seen in a study by Ingram [30], reporting that the knowledge of the English farmer correlates with years of trial and error.

Central to the knowledge adoption in old farmer and young farmers are structural factors: access to land, capital, technology, human resource skills, influential people, or institutions. This is based on the interview data as follows:.

"I don't have coconut plantation as the land still belongs to my parents. Thus, I buy coconuts from farmers since cultivating coconut takes time. In terms of financial capital, I collaborate with some friends, signing MOU where the risks are distributed equally." MA, UMK Coconut Copra, farmer 31

"I learn from more than one knowledge resource since I am aware that success is not about my achievement. It requires others' support since relying on knowledge for my personal gain is insufficient. I studied knowledge and technology of agriculture and food. I also took part in training and technical guidance at the Ministry of Industry and Trade. I also learned from UNG and UGM lecturers." AA, Head of VCO processing, farmer 6

"My business was hampered by problems with the processing machine. Due to limited financial condition, my parents lend me some money. I borrowed machineries from other people. I tried to make cooking coconut oil only because my money was only suffice for this business. I stopped my business and focused on copra because the process is not complicated." MA, Copra business, farmer 31

"We established this coconut business as a marketing network for processed products by SME members to support each other. If there are consumers seeking for our products, we communicated it with SMEs. In terms of access to capital, my fellow women farmers received credit support from the bank. There were also people who wanted to invest in their shares me and my fellow farmers have not responded to the decision." SY, Chair of the women farmers of refined coconut oil processing, farmer 32

Structural factors of access to knowledge between generations between old and young farmers have different farming orientations. For old farmers, aspects of land access focus on coconut intensification and rejuvenation. Meanwhile, young farmers prefer market-oriented product diversification and processed products with the support of online digital media. Such differing perspectives are underpinned by the fact that plantation areas are not the priority for young farmers. This farmer group does not own land and they claim that growing coconuts from scratch will take a long time. Authors of ref. [8] systematically describe the differences in perceptions of old and young farmers regarding access to land. For old farmers access to managing land for farming is the main thing, while young farmers prioritize access to information needs through digital media. Young farmers claim that land is something inherited from their parents, and it takes time to grow coconut plantation from the beginning. In terms of access to capital, skills, and technology, old farmers are more likely to take risks in accessing capital. They are less interested in taking initiative to improve skills and technological innovation. On the contrary, young farmers, despite limited capital access, focus on improving skills and business networks through technical training by government and private institutions and universities. According to Rajak [31], agriculture stakeholders should utilize technology in increasing production and individual capabilities. Modern agriculture development requires biotechnology, advanced irrigation systems, nanotechnology, the use of organic fertilizers, intensive tillage, monoculture, organic pest controls, and modification with enatic plants to boost productivity and profitability as a way of maintaining farmers' livelihoods. Authors of ref. [2] found that the above conditions are relevant to the situation experienced by young farmers in Europe, who have limited capital and access to formal credit. Therefore, young farmers rely more on their labor, skills and knowledge, family support, and their social networks. The difference in orientation between old farmers and young farmers is due to the tendency of old farmers in participating in government programs for coconut rejuvenation. Another factor is the limited land for planting coconuts since most areas have been allocated for maize farming.

Differences in action orientation and variation in knowledge co-creation involving young and old farmers in coconut farming practices are one of the factors to preserve local coconut businesses in Gorontalo, preventing them from extinction due to the widespread growth of businesses of hybrid coconut, palm oil, and modern coconut oil in Indonesia. Many old farmers in Gorontalo still maintain their coconut plantation areas through replanting for long-term goals and a source of income. In contrast, young farmers maintain the existence of coconut farming by integrating seasonal crops, such as maize, peanuts, bananas, and chilies, into their coconut plantations. This intercropping system aims to earn additional income.

The above finding is in line with the result of ref. [32] confirming that the sustainability of coconut plantations with an intercropping system positively impacts land maintenance. Furthermore, fertilization on intercrops increases coconut nutrition and nitrogen in the soil resulting in easier harvesting. In addition, despite the differences in the orientation between the two generations in coconut farming, knowledge co-creation promotes sustainability of livelihood. This is because the diversity of knowledge co-creation encourages continuous interaction and

distribution of knowledge between generations. This is in accordance with the argument by Ngulube and Stilwell [33] that in achieving a sustainable agriculture, communities must serve as the creator, distributor, and medium of knowledge sharing process.

Regeneration of farmers in the sustainability of coconut farming tends to be supported by two sources of innovation. The first source refers to innovation that comes from knowledge co-creation of the old farmers and the young farmers with local actors who interact with them. And the second source refers to external innovation. Scientific knowledge-based research has long been conducted for coconut modernization. Kallapur et al. [34], for instance, have developed a technique to identify variations of coconut aroma. Authors of ref. [35] have formulated indicators of sustainability assessment for coconut intensification. Authors of ref. [36] have examined the impact of extreme weather on coconut productivity which correlates with the result seen in ref. [37]. Their study finds that the impact of extreme weather corresponds to strategic plans to increase agricultural yields on commodities that depend on rainfall due to changes in rain and temperature. It is, therefore, necessary to formulate an adaptive strategy for sustainable crop production and a policy of agricultural crop production methods. Another solution has been proposed by Wayangkau et al. [38] by the application of Internet of Things in precision farming to increase production with an Arduino microcontroller-based automatic monitoring system. It is used to measure soil moisture and temperature as an effort of anticipating the impact of weather, temperature, and humidity for maintaining crop quality. Another solution was proposed by Handoyo et al. [39]. Their study has promoted coconut klappertaart as an ethnic food with good market prospects. This means that scientific knowledge-based research findings can enrich knowledge co-creation among coconut farmers to maintain the continuity of coconut farming. All of the studies mentioned above will further support the peasantry model developed by van der Ploeg [1] regarding the emergence of the new peasant generation. Based on the description above, the grounded theory scheme produced in this study is interrelated: farmer regeneration as a causal condition, where knowledge co-creation serves as an interaction and coconut farming sustainability as a consequence.

4 Discussion

This study finds significant differences in the orientation between old farmers and young farmers and its correlation to sharing knowledge and information in knowledge co-creation. On that ground, the present work recommends a policy to encourage the maintenance and development of coconut and cooking oil, which appears to be the income source for local people. The policy is a complement to the oil palm expansion and modern coconut oil factories as a profit source for financiers. Enhancing associations of coconut commodities are essential through the involvement of old farmers and young farmers. It should consider the types of coconut processing and partnership or network. For technical recommendation, technical guidance is essential in knowledge co-creation between young farmers and old farmers. This can be done by improving skills and establishing partnerships with institutions, including government and private institutions and universities.

5 Conclusion

Old farmers focused on the revitalization of coconut trees for long-term purposes. The knowledge co-creation process among this farmer group (with other stakeholders) emphasized the copra and cooking oil production; both products were businesses passed down from generation to generation. Young farmers, however, put their concern on coconut tree integration with annual plants (e.g., maize, peanut, and chili) for short-term purposes. Their collaboration with stakeholders focused on VCO and innovative products resulted from the adaptation of foreign technology. In conclusion, coconut business sustainability is the byproduct of knowledge co-creation between old farmers and young farmers. The condition mentioned previously impacts the sustainability of coconut oil business. In other words, the barriers and dynamics of access to knowledge between old farmers and young farmers occur due to several differences. Some of these include responses in accessing and responding to information and knowledge innovation, media access to knowledge sources, and motivation to conduct repeated experiments and trials. Failure to process coconuts does not dampen the enthusiasm of young farmers to innovate for the success of their farming practices. The dynamics and structural factors of young farmers identified in this study also contribute to the continuity of intergenerational knowledge co-creation for a sustainable coconut farming.

Further studies may look at the contribution of multiple actors to knowledge co-creation between farmer generations through interactions with other stakeholders, such as government research institutions, industry, NGOs, higher education research institutions, and journalists.

This interaction may enable the acceleration and innovation between old farmers and young farmers.

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References

[1] van der Ploeg JD. The new peasantries rural development in times of globalization. 2nd edn. New York: Routledge; 2018.
[2] Milone P, Ventura F. New generation farmers: rediscovering the peasantry. J Rural Stud. 2019;65(May):43–52.
[3] Wójcik M, Jeziorska-Biel P, Czapiewski K. Between words: a generational ussion about farming knowledge sources. J Rural Stud. 2019;67(February):130–41. doi: 10.1016/j.jrurstud.2019.02.024.
[4] van Ewijk E, Ros-Tonen MAF. The fruits of knowledge co-creation in agriculture and food-related multi-stakeholder platforms in sub-Saharan Africa – a systematic literature review. Agricultural systems. 2021;186:102949.
[5] Akpo E, Crane TA, Vissoh PV, Tossou RC. Co-production of knowledge in multi-stakeholder processes: analyzing joint experimentation as social learning. J Agric Educ Ext. 2015;21(4):369–88.
[6] Struik PC, Klerkx L, van Huis A, Röling NG. Institutional change towards sustainable agriculture in West Africa. Int J Agric Sustain. 2014;12(3):203–13.
[7] Laforge JML, McLachlan SM. Learning communities and new farmer knowledge in Canada. Geoforum. 2018;96(December 2017):256–67. doi: 10.1016/j.geoforum.2018.07.022.
[8] Junais I, Samsuar, Daniel, Ali HM, Yusran, Syarif A, et al. Young farmers and parents' perception for the future of agriculture: socio-spatial integration of coffee farmers in Jeneponto Regency. IOP Conf Ser Earth Environ Sci. 2020;473(1).
[9] Statistik BPPG. Gorontalo Dalam Angka 2020. 2020;3(2):54–67, http://repositorio.unan.edu.ni/2986/1/5624.pdf.
[10] BPS Gorontalo Province. Gorontalo Province in Figures 2020. 2020.
[11] NSLIC. Kajian Ekonomi Komoditas Kelapa Provinsi Gorontalo by. 2020.
[12] Regeer BJ, Bunders JFG. Knowledge co-creation: interaction between science and society. The Netherlands: RMNO; 2009.
[13] Herrmann-Pillath C. The art of co-creation: an intervention in the philosophy of ecological economics. Ecol Econ. 2020;169:106526.
[14] Wyborn C. Co-productive governance: a relational framework for adaptive governance. Glob Environ Change. 2015;30:56–67.
[15] Norström AV, Cvitanovic C, Löf MF, West S, Wyborn C, Balvanera P, et al. Principles for knowledge co-production in sustainability research. Nat Sustain. 2020;3(3):182–90.
[16] Turner JA, Horita A, Fielke S, Klerkx L, Blackett P, Bewsell D, et al. Revealing power dynamics and staging conflicts in agricultural system transitions: case studies of innovation platforms in New Zealand. J Rural Stud. 2020;76(February):152–62. doi: 10.1016/j.jrurstud.2020.04.022.
[17] Douthwaite B, Keatinge JDH, Park JR. Why promising technologies fail: the neglected role of user innovation during adoption. Res Policy. 2001;30(5):819–36.
[18] Gielen PM, Hoeve A, Nieuwenhuis LFM. Learning entrepreneurs: learning and innovation in small companies. Eur Educ Res J. 2003;2(1):90–106.
[19] Van Rijn F, Bulte E, Adekunle A. Social capital and agricultural innovation in Sub-Saharan Africa. Agric Syst. 2012;108:112–22.
[20] Corbin JM, Strauss A. Grounded theory research: procedures, canons, and evaluative criteria. Qual Sociol. 1990;13(1):3–21.
[21] Bertolozzi-Caredio D, Bardaji I, Coopmans I, Soriano B, Garrido A. Key steps and dynamics of family farm succession in marginal extensive livestock farming. J Rural Stud. 2020;76(March):131–41. doi: 10.1016/j.jrurstud.2020.04.030.
[22] Salman D, Kasim K, Ahmad A, Sirimorok N. Combination of bonding, bridging and linking social capital in a livelihood system: nomadic duck herders amid the covid-19 pandemic in South Sulawesi, Indonesia. For Soc. 2021;5(1):136–58.
[23] Kasurinen J. Software organizations and test process development [Internet]. Adv Comput. 2012;85:1–63. Elsevier Inc. doi: 10.1016/B978-0-12-396526-4.00001-1.
[24] Cofré-Bravo G, Klerkx L, Engler A. Combinations of bonding, bridging, and linking social capital for farm innovation: how farmers configure different support networks. J Rural Stud. 2019 Jul 1;69:53–64.
[25] Bohren MA, Vogel JP, Tunçalp Ö, Fawole B, Titiloye MA, Olutayo AO, et al. By slapping their laps, the patient will know that you truly care for her": a qualitative study on social norms and acceptability of the mistreatment of women during childbirth in Abuja, Nigeria. SSM – Popul Health. 2016;2:640–55. doi: 10.1016/j.ssmph.2016.07.003.
[26] Cochetel C, Phiboon K, Faysse N. Young farmers in Thailand: small numbers, but diversified projects. Paris, France: AFD-MEAE; 2019.
[27] Zhang Y, Zhang M, Luo N, Wang Y, Niu T. Understanding the formation mechanism of high-quality knowledge in social question and answer communities: a knowledge co-creation perspective. Int J Inf Manage. 2019;48(July 2018):72–84. doi: 10.1016/j.ijinfomgt.2019.01.022.
[28] Anderson S, Fast J, Keating N, Eales J, Chivers S, Barnet D. Translating knowledge: promoting health through intergenerational community arts programming. Health Promot Pract. 2017;18(1):15–25.

[29] Triste L, Debruyne L, Vandenabeele J, Marchand F, Lauwers L. Communities of practice for knowledge co-creation on sustainable dairy farming: features for value creation for farmers. Sustain Sci. 2018;13(5):1427–42.
[30] Ingram J. Technical and social dimensions of farmer learning: an analysis of the emergence of reduced tillage systems in England. J Sustain Agric. 2010;34(2):183–201.
[31] Rajak ARA. Emerging technological methods for effective farming by cloud computing and IoT. Emerg Sci J. 2022;6(5):1017–31.
[32] Pabuayon IM, Medina SM, Medina CM, Manohar EC, Villegas JIP. Economic and environmental concerns in philippine upland coconut farms: an analysis of policy, farming systems and socio-economic issues; 2008. p. 10.
[33] Ngulube P, Lwoga E. Knowledge management models and their utility to the effective management and integration of indigenous knowledge with other knowledge systems. IAJIKS. 2007;6(2):117–31, https://www.ajol.info/index.php/indilinga/issue/view/3544.
[34] Kallapur S, Hegde M, Sanil AD, Pai R, Sneha NS. Identification of aromatic coconuts using image processing and machine learning techniques. Glob Transit Proc. 2021;2(2):441–7.
[35] Rodrigues GS, Martins CR, de Barros I. Sustainability assessment of ecological intensification practices in coconut production. Agric Syst. 2018;165(June 2018):71–84. doi: 10.1016/j.agsy.2018.06.001.
[36] Pathmeswaran C, Lokupitiya E, Waidyarathne KP, Lokupitiya RS. Impact of extreme weather events on coconut productivity in three climatic zones of Sri Lanka. Eur J Agron. 2018;96(March):47–53. doi: 10.1016/j.eja.2018.03.001.
[37] Jabal ZK, Khayyun TS, Alwan IA. Impact of climate change on crops productivity using MODIS-NDVI time series. Civ Eng J. 2022;8(6):1136–56.
[38] Wayangkau IH, Mekiuw Y, Rachmat R, Suwarjono S, Hariyanto H. Utilization of IoT for soil moisture and temperature monitoring system for onion growth. Emerg Sci J. 2020;4(Special Issue):102–15.
[39] Handoyo CC, Claudia G, Firdayanti SA. Klappertaart: an Indonesian e Dutch influenced traditional food. J Ethnic Foods. 2017;5(December):1–6. doi: 10.1016/j.jef.2017.12.002.

Appendix

Appendix 1. Questionnaire

A. Socio-economic characteristics of the informants

Age: ……
Formal Education: ……
Non-formal Education: ……
Farming Experience (year): ……
Income (hectare/growing season): ……
Land Area (hectare): ……
Land Ownership: Owner/Farmer
Main Knowledge Sources:

1. Family
2. Friend
3. Leader of Farmer Groups
4. Management Board of Farmer Groups
5. Extension Agent
6. Farmer Partners (collectors, factories, banks, agencies/regional organization, agricultural research institutes, higher education research institutes)

Orientation of old farmers and young farmers

1. What are your approaches in the cultivation, processing, and marketing of coconut farming?
2. What are the sources of knowledge in coconut cultivation, processing, and marketing of coconut farming?
3. Is there any use of technology in the cultivation, processing, and marketing of coconut farming? Mention the technology instruments?
4. Are there tools, ways, and methods of knowledge in cultivating, processing, and marketing coconut farming?
5. What is the motivation of farmers in adopting the use of cultivation technology, processing, and marketing of coconut farming?
6. What are the changes in knowledge and technology in the aspects of cultivation, processing, and marketing?
7. Have farmers received training on new technologies? Which training and what institution?
8. Is there a network or connection with other institutions for technology innovation?
9. Have you ever consulted on technology services and agricultural innovation when you have problems in coconut farming?
10. Is there interaction/communication in farming within the family?
11. In your family, who is the one frequently invited to communicate to share agricultural knowledge and technology? What types of communication?

B. Knowledge co-creation between old farmers and young farmers

1. What are knowledge and technology passed on to peer farmers, old farmers, and younger farmers?
2. What are methods and means of technology passed on to peer farmers, old farmers, and younger farmers?
3. What are methods and means of technology passed on to peer farmers, old farmers, and younger farmers?
4. What are the changes in the knowledge of peer farmers, old farmers, and younger farmers after the dissemination of technology support?
5. Do peer farmers, old farmers, and younger farmers share the knowledge and means of technology?

6. How do the peer farmers, old farmers, and younger farmers respond to the knowledge and means of technology?
7. Do the knowledge and means of technology impact the agricultural activity? Explain it.
8. Do the peer farmers, old farmers, and younger farmers immediately apply the knowledge and means of technology?
9. What are challenges peer farmers, old farmers, and younger farmers in applying knowledge and means of technology?

C. Barriers, access dynamics, and structural factors

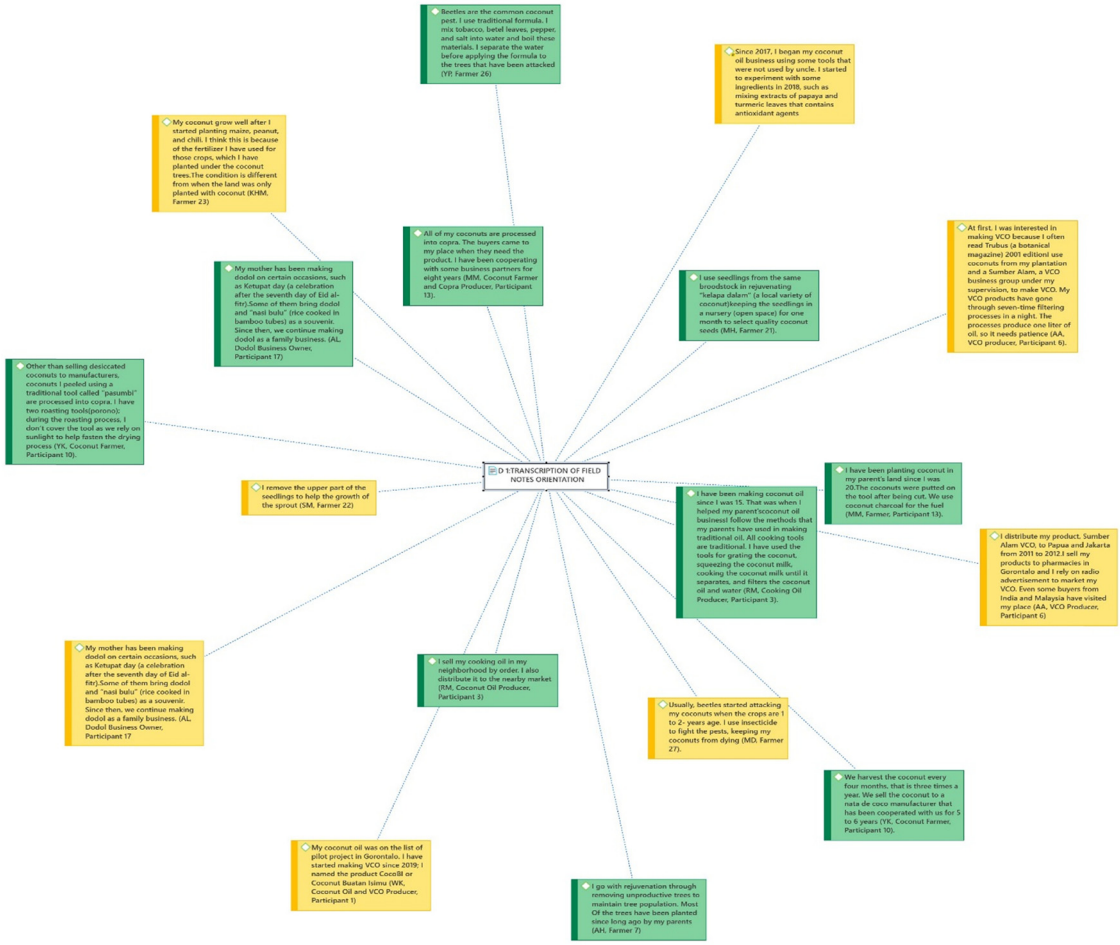
1. How do peer farmers, old farmers, and younger farmers respond to information and new technology?
2. Have you ever failed in making processed coconut products? How do you cope with the failures?
3. What are the structural factors constraining access to land, technology, capital? How do you cope with those problems?

Appendix 2. Characteristics of the respondents

No./farmer's initial	Socio-economic characteristics								Interview duration (min)
	Farmer generation category		Land area (hectare)	Educational background	Work experience (year active)	Category of activity			
	Young 20–45 years	Old 46–65 years				Commodity	Processing	Marketing purposes	
1. SA	42	—	3	Bachelor	20	Coconut	Fresh fruit	Collectors	75
2. AS	—	50	3	Junior high school	30	Coconut	Copra	Factory	35
3. RM	—	60	1	Elementary school		Coconut	Traditional VCO producer	Market, neighbor	30
4. T	43	—	17	Master's degree	5	Coconut	VCO, fresh fruit	Factory	65
5. SZ		57	4	Elementary school	27	Coconut	Fresh fruit	Collector	30
6. AA	44	—	3	Bachelor	18	Coconut	VCO	Pharmacy, export	40
7. AH		50	10	Junior high school	15	Coconut	Copra producer	Copra factory	30
8. YH	—	59	2	Junior high school	29	Coconut	Copra producer, fresh fruit	Copra factory	30
9. KN	45	—	1	New high school	10	Coconut	VCO and coconut cake	Market, supermarket	40
10.YK	—	51	1.5	Senior high school	36	Coconut	Copra, fresh fruit	Factory	35
11. SM	—	69	1	Elementary school	38	Coconut	Copra, fresh fruit	Collector	30
12. AB	—	60	3	Senior high school	30	Coconut	Copra, fresh fruit	Factory, collector	35
13. MM	—	67	5	Junior high school	20	Coconut	Copra, fresh fruit	Factory, collector	30
14. SU	37	—	1	Senior high school	5	Coconut	Coconut bonsai crafter	Exhibition	40
15. TN		47	1	Senior high school	20	Coconut	Dodol (traditional snack) producer	Market, airport, export	35
16. WK	25	—	3	Bachelor	4	Coconut	Traditional cooking oil, VCO, white copra	Export, exhibition	75
17. AL	20		1	Senior high school	2	Coconut	Dodol (traditional snack) producer	Export	40
18. OP	—	51	3	Senior high school	19	Coconut	Copra, fresh fruit	Factory, collector	35
19. LA	—	48	2	Senior high school	15	Coconut	Copra, fresh fruit	Factory, collector	35
20. HH	29	—	3	Bachelor	8	Coconut	Coconut seedlings	Farmer	40
21. MH	—	55	5	Senior high school	20	Coconut	Copra, coconut seedlings, fresh fruit	Factory, collector, farmer	30
22. SM	44	—	2	Bachelor	5	Coconut, lowland rice	Fresh fruit, VCO	Market, collector	35
23. KH	44	—	30	Senior high school	10	Coconut, maize, chili, peanut	Copra, white copra, fresh fruit	Factory, collector	30
24. AH	43	—	2	Junior high school	7	Coconut, maize, peanut	Copra, fresh fruit	Collector	35
25. AB	—	70	2	Elementary school	40	Coconut, maize	Copra, fresh fruit	Collector	30
26. YP	—	60	2	Elementary school	30	Coconut, maize	Copra, fresh fruit	Collector	30
27. MD	29	—	1	Bachelor	5	Coconut, maize	White copra, fresh fruit	Factory, collector	45
28. HG	—	68	20	Junior high school	44	Coconut, maize	Copra, fresh fruit	Factory, collector	30
29. RH	—	40	4	Senior high school	5	Coconut	Fresh fruit	Factory, collector	40
30. RA	31	—	1	Bachelor	6	Coconut, maize	White copra, fresh fruit	Factory, collector	45

Appendix 3. Data process results using the Atlas.ti

3.1 Action orientation of old and young farmers



Note : Transcription Old Farmer | Transcription Young Farmer

3.2 Knowledge co creation of old and young farmers

3.3 Obstacles, dynamics and other structural access to knowledge