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SUSTAINABILITY OF DRYLAND, FARMERS, AND LOCAL INDUSTRY: DRYLAND OF CASSAVA MODEL

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Abstract: So far, dryland have very low productivity due to many factors, including low nutrient content, difficulty in managing their levels, inadequate farmer knowledge, and high management costs. This impacts low-income communities' economies leading to most people living in dryland areas being poor. This research aims to design and promote a dryland management model based on a case study conducted in the East Java Province. This quantitative research method was conducted through a survey approach in the Bondowoso area using cassava production and its management into *tape* products. The population used for the survey were cassava farmers and business actors in the *tape* industry which were as many as 99 respondents and 10 supporting respondents. Data analysis was conducted through instrument tests, data processing, prerequisite test, and Kendall's Tau test. The findings of this study found that the dryland of cassava model had higher element (f) in the farming and *tape* industry, more appropriate land management (physical), complete the facilities and infrastructure, and better existing institutional management. The implication is that an active role by both government and non-government institutions is needed to support the community by providing intensive training and counselling to improve the quality of land management and industrial production innovation.

Keywords: Sustainability, dryland, farmers, industry, model.

Introduction

Indonesia has a dryland potential of 148 million ha, consisting of only 76.22 million ha of dryland being used for agriculture and the remaining 71.78 million ha has no potential of being used for agriculture. Agricultural dryland is mainly found in the lowlands and is spread to Java, Kalimantan, Sumatra, and Bali Nusa Tenggara (Bafdal *et al.*, 2015). The prospect of dryland agriculture has excellent opportunities to develop various superior commodities, developing integrated agriculture between food crops and livestock, which makes it possible to alleviate poverty (Ahmed *et al.*, 2022). However, so far, the potential of dryland agriculture has yet to be managed optimally, and as such its productivity still needs to improve. This is because there is still a need for understanding the possibility of dryland that is integrated and comprehensive to develop dryland agriculture.

Dryland is an area that economically has low production potential (Rustinsyah, 2015), as a result, people living in dryland areas are unable to fully benefit from the land and thus are poor (Smith *et al.*, 2009; Matheus *et al.*, 2017). The economic level of the community could be higher because the community needs help to manage drylands optimally. Community activities utilise nature to produce food, energy, and other materials around it for survival (Pranadji, 2006). Many obstacles and problems are faced in dryland management, such as limited biophysical dryland, land degradation, land productivity, crop production, drought, economic infrastructure, and production technology (Matheus *et al.*, 2017).

Drylands in Indonesia are experiencing land degradation caused by erosion and improper agricultural management (Nurida & Jubaedah, 2014). Land degradation causes organic matter to be present in dryland at low to deficient levels (Rachman & Dariah, 2008). Farmers who rarely do soil amelioration can cause the land to further degradation to accelerate and decrease species diversity (Heryani & Rejekiningrum, 2020). Previous studies stated that unsustainable land management hurts the environment and economic conditions of the people in dryland areas (Ayeb-Karlsson *et al.*, 2016; Kim *et al.*, 2020; Zaini *et al.*, 2022). Thus, the management of dryland agriculture needs to get more attention to ensure the environmental and economic sustainability of the surrounding community.

The management of dryland agriculture in Bondowoso Regency, East Java Province, also needs more attention because it has a large potential in growing cassava. This dryland farming of cassava has become the foundation of livelihood for some farming communities in the Bondowoso Regency. One area famous for dryland agriculture is Wringin, a cassava producer and the centre of *tape* production in East Java Province. This can be seen in the production of 900 tons of cassava per day which is directly absorbed by the *tape* industry and the rest is used by the tapioca factories (Navisa *et al.*, 2014).

The pattern of dryland management for cassava so far conducted by farmers is still conventional. They must learn the importance of soil quality to support optimal cassava productivity. Soil quality optimally supports plants' productivity in its ecosystem, which is further supported by environmental and human qualities (Cardoso *et al*., 2013; Minarsih & Hanudin, 2020; Abdullah *et al.*, 2022; Akbar *et al*., 2022). Cassava in Wringin is developed by planting the cassava on slopes with potential erosion (Faizal *et al*., 2020). Reduced soil nutrients result in land degradation (Ma *et al.*, 2016; Adimassu *et al*., 2017; Mishra *et al.*, 2022).

The strategy in dryland management so far has only been conducted based on physical and human aspects. The dryland management strategy based on physical elements can be done by increasing the cropping patterns of three crops in the drylands to increase agricultural productivity (Zhao *et al*., 2009) and also by paying attention to the soil quality index, which can increase plant productivity. Air, water quality, adding organic matter to the soil using fertilisation, environmental health, and humans in the ecosystem can also affect productivity (Weil & Magdoff, 2004). The human aspect is seen from the perspective of the cycle of agricultural systems, such as recycling agricultural waste which improves the community's economy (Zhao *et al*., 2009).

Several previous studies have examined dryland use optimisation models, including soil quality index models (Nugroho *et al.*, 2011), mathematical models (Zhao *et al*., 2009), irrigation system development simulation models (Prabowo *et al.,* 2014), run-off management integrated farming design models (Bafdal *et al*., 2015), deep learning models for dryland farming application (Mithra & Nagamalleswari, 2022). This research examines dryland management from the view of agricultural science and its physical aspects only. A dryland management model that includes land (physical), human (farmers) aspects and local industry around the land is needed. This will enable farming communities to live sustainably by optimising the potential of suitable plants grown on dryland.

With various problems of dryland management for cassava like this, a strategy is needed to maintain sustainable livelihoods using the modified results of the Triple-A model and Kendall's Tau model. The Triple-A model is a rural area analysis unit comprising 3 indicators: Assets, access, and activities. This Triple-A model was developed from the Sustainable Livelihoods framework (Scoones, 1998). Kendall's Tau model is a statistical tool that can be used to build a model based on causality between two or more variables to be achieved. This research aims to design and promote a dryland management model based on a case study in East Java Province. The uniqueness of this research is that it is a conceptual model in the form of a dryland of cassava model that will be able to fill the gaps related to existing dryland management models. This model is offered to tropical communities in developing countries having a seasonal crop potential. The results of this research will help local governments in supporting the development of industrial estates that provide added value to agricultural products. So that it can enhance and strengthen the economic value of the farming communities and local industries in areas characterised by dryland. This is important because climate change makes communities that depend on dry land farming vulnerable (Mortimore *et al*., 2009) to environmental and other factors.

Literature Review

The term dryland is defined from several aspects (Walker, 2016). From the irrigation availability perspective, dry land is land utilised without standing water, both from general irrigation and rain for a long time (Utomo, 2014). Based on the aspect of rain availability, dry land is defined as land that is not affected by rain anymore, where the amount of rainfall is below 2,000 mm/year and the average wet month is only 3-5 months, and the dry season is 7-8 months (Rollenbeck, 2011) (Notoadiraprawiro, 1998; BBSDLP, 2012; Heryani & Rejekiningrum, 2020). The rainfall distribution throughout the year is uneven and erratic in this region. This can be seen from the more extended rainfall periods in the dry season at a lower intensity (Kartiwa *et al*., 2010).

The term dryland used by the Agroecosystem Research Group states the equivalent of rain-fed cropland and the absence of long-term inundation in a one-resistant period (dryland agriculture) (KEPAS, 1985; Sukarman *et al.*, 2012; Adimiharja & Agus, 2000). Thus, dry land has a planting season once a year and has no irrigation facilities available.

Dry land is an agroecosystem with great potential for agricultural businesses, including horticulture, food crops, and annual crops (Helviani *et al*., 2021). However, dry land also has its limitations regarding rainfall, low soil fertility, and high soil acidity. Thus, managing dry land requires the right strategy in creating prospects for conservation and promoting sustainability to increase the economy with the help of technology, i.e., both the biophysical environment and the socio-economic environment. One of the strategies for managing and developing dry land is dry land farming. Dry land agriculture in Indonesia is mainly done with cassava (94%), peanuts (82%), corn (83.9%), and maize (55.2%) (Kasryno & Soeparno, 2013).

Dry land can be managed optimally through dryland farming, but its management must prioritise conservation, sustainability, and economic aspects. Managing these three elements of dryland farming are interrelated and mutually influence each other (Ayeb-Karlsson *et al*., 2016; Kim *et al*., 2020; Zaini *et al*., 2022). Thus, this sustainable dryland agriculture must be managed in order to produce food, fodder, and fuel in an integrated manner.

Materials and Methods

This research was conducted on dryland agriculture in Wringin District, the Industrial Centre Area of Bondowoso Regency, East Java (Figure 1).

A Sampling technique using simple random sampling was conducted. The sampling framework in this research refers to cassava farmers and business actors in the *tape* industry centre, as many as 99 respondents from farmers and industry players, as well as 10 experts from government agencies and non-government institutions participated in the survey. Primary data was collected for the surveys from competent sources with experience in managing dry land and *tape* industry players—the criteria for determining the sample was done using the non-probability technique of farmers in Wringin District. Open and closed instruments were designed to analyse and identify the management of *tape* industry centres. Semi-structured interview techniques were used to obtain more detailed information regarding specific issues and to study institutional patterns

Location 1: Jatisari Village
7^{0}49’32.078” LS and 113^{0}45’15.915” BT

Location 2: Sumbermalang Village
7^{0}51’2.490” LS and 113^{0}46’47.094” BT

Location 3: Jambe Wungu Village
7^{0}50’57.548” LS and 113^{0}45’55.451” BT

Location 4: Wringin Village
7^{0}48’39.449” LS and 113^{0}46’15.421” BT

Figure 1: Dryland of cassava in Wringin District

in mentoring and training. This extensive and sufficient experience of the participants can help in understanding dryland management and the industrial sector can also compensate for the limitations of research methods on the number of samples.

Data was collected using observation, questionnaires, and conducting interviews. Physical environment data (dryland) was obtained from a large research section entitled ‘Study of Cassava Cultivation Areas as a Support for the *Tape* Industry in Bondowoso Regency as Learning Materials for Agricultural Geography’ and was been published in the form of a monograph book (Aristin *et al*., 2022). Data analysis of this study was conducted in stages, namely (1) Instrument Test, (2) Data Processing, (3) Prerequisite Test, and (4) Statistical Test in the form of Kendall’s Tau Test. This test is the basis for the correlation model between indicators describing research variables (Table 1). The results of Kendall’s Tau model and the Triple-A model were used as the basis for the conceptual model design for sustainable dryland management.

Results and Discussion

This study’s social (human) aspect is seen from cassava farmers and business actors in the *tape* industry, where the cassava commodity and the *tape* industry are the leading sectors in Bondowoso Regency. The social aspect is one of the primary keys to developing regional potential because humans are the decision-makers. In this industrial centre area in Wringin District, Bondowoso Regency, the relationship between the roles of cassava farmers and business players in the *tape* industry is remarkably close. Cassava farmers are the main actors in managing dryland agriculture around the *tape* industry. In addition, cassava yields are the principal factor in the sustainability of the *tape* industry players.

The data processing results of the closeness values of the sub-elements of cassava farmers and business actors in the *tape* industry (Table 2).

The results of the coefficient values above are weighted and rated on the sub-elements of farmers, industry, physical environment (dryland), facilities and infrastructure, and institutions (Table 3). The weightage of each element is based on a modification of the Triple-A model concept. Kendall's Tau model results make a dryland management model design for cassava. The model design is presented as a pentagram (Figure 3) which shows the relationship between the aspects of assets, accessibility, and activities in the industrial centre area of Bondowoso Regency.

Sub Elements of Dryland of Cassava Model Design

The design of this cassava dryland management model which is called the Dryland of Cassava Model, is a modification of the Triple-A and Kendall's Tau models. This model design is a conceptual model designed to increase the development of cassava farming areas in dryland, where cassava is the main commodity supporting the *tape* industry as the leading sector in the Bondowoso Regency. The sub-elements consist of cassava farmers, industry, and the physical environment in the form of dryland (assets), facilities and infrastructure (accessibility), and institutions (activity).

Table 1: Variable description

No.	Variable	Sub Variable
1	Human resources characteristic	Level of education Level of income Number of family members
2	Cassava farmers elements	Land characteristics Financial capital Level of productivity Technology Improvement production strategy Labor Farmer competence Distribution product Government role Availability of facilities and infrastructure Institutional
3	*Tape* industry business actors elements	Raw material Financial capital Labor Wages Product processing system Production cost *Tape* production Distribution Government role Availability of facilities and infrastructure Institutional

Table 2: The Value of the relationship between sub variables of cassava farmers and the *Tape* industry

The Value of the Relationship Between the Sub-variables of Cassava Farmers		
Subvariable	**Coefficient Value**	**Closeness Level**
Land characteristics	0.618	Strong
Productivity rate	0.515	Strong
Capital	0.242	Very weak
Technology	0.129	Very weak
Farmers competency	0.383	Enough
Improvement strategy	0.357	Enough
Distribution	0.354	Enough
Labour	0.223	Very weak
Government role	0.018	Very weak
The Value of the Relationship Between the Sub-variables of the *Tape* Industry		
Subvariable	**Coefficient Value**	**Closeness Level**
Raw material	0.428	Enough
Capital	0.367	Enough
Labour	0.661	Strong
Production processing	0.290	Enough
Wages	0.524	Strong
Production cost	0.299	Enough
Distribution	0.204	Very weak
Government role	0.017	Very weak

The design of the dryland management model for cassava is called the Dryland of Cassava Model, which is based on the following concept:

Dryland of Cassava Model
= f (Farming Business + Industry + Physical Land + Infrastructure + Institutions)

The design of this conceptual model it can be said that the higher the element (f) of farming, surrounding industry, the more appropriate the land management (physical), and the more complete the facilities and infrastructure and the better the existing institutional management, the more optimal the cultivation area. Agriculture would then better support industries in the central area.

Sub Elements of Cassava Farmers (Farming)

Cassava farmers are important in managing dryland to produce cassava productivity. Cassava is the *tape* industry's leading supplier, the basis for which can be seen at the Bondowoso Regency. The characteristics of farmers are directly related to farming activities, so this becomes the most crucial element (Asmarantaka & Zainuddin, 2017) and is also closely related to formal education. Formal education will result in farmers thinking about optimal agricultural land management.

The inhibiting factors in this sub-element of farming must be improved. The aim is to optimise the role of cassava farmers in increasing their productivity. In this case, the inhibiting factors include technology, capital, and the government.

Table 3: Weighting and scoring sub elements

Sub Element	Weight	Rating	Weight Score
Sub Element of Farming Business (Assets)			
Land	0.078	4	0.313
Capital	0.031	3	0.092
Technology	0.016	3	0.049
Farmers competency	0.049	4	0.194
Upgrade strategy	0.045	3	0.136
Marketing	0.045	3	0.135
Government role	0.002	3	0.007
Sub Total	0.266		0.926
***Tape* Industry Sub Element (Asset)**			
Raw material	0.054	4	0.217
Capital	0.047	4	0.186
Labour	0.084	4	0.335
Production processing	0.037	3	0.110
Wages	0.066	3	0.199
Production cost	0.038	3	0.114
Marketing distribution	0.026	3	0.078
Government role	0.002	3	0.006
Sub Total	0.354		1,245
Physical Sub Elements (Asset)			
Land suitability	0.127	4	0.507
Sub Elements of Facilities and Infrastructure (Access)			
Availability of infrastructure	0.127	3	0.380
Institutional Sub Element (Activity)			
Institutional	0.127	3	0.380
TOTAL	1		

Technology

The cassava dryland farming system in Bondowoso Regency still relies on traditional farming methods because cassava farmers have yet to use modern farming tools. This causes the management of dryland not to be optimal, so cassava production is thus also not optimal. The productivity of cassava is influenced by the potential of the land and the level of the production technology (Yuniwati *et al*., 2015; Fu *et al*., 2018; Zakaria *et al*., 2021).

Land potential is one of the main assets in agricultural development. Drylands that need more nutrients require land improvements such as the use of fertilisers, mulch, the manufacture of mounds, the construction of waterways, and crop rotation. This is one way to maintain healthy soil quality, which aims to realize dryland agriculture for cassava plants in a sustainable manner. The Food and Agriculture Organisation (FAO) proposes five primary keys as a reference in the sustainability of cassava production, namely (1) increasing plant

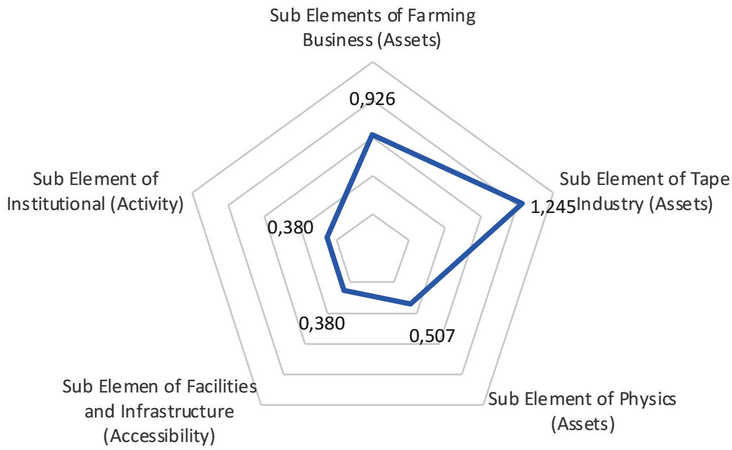

Figure 2: Pentagram of dryland management model for cassava

nutrition by maintaining soil health, (2) crop rotation by sequential rotation with different plant species and varieties, (3) the selection of seed plants with the best quality according to the environment, (4) water management (Howeler *et al.,* 2013).

Agricultural development can be successful if farmers use technology. Technology is used for land management and dryland agricultural crop production processing. Technology increases productivity and business efficiency, increasing the added value of the products produced and thus the farmers' income (Mosher, 1968). Technological developments are directly proportional to changes and increasing human development due to advances in accessing information technology (Muchdie & Nurrasyidin, 2019).

Success in farming is closely related to the competence possessed by farmers. This competence is closely related to the formal education of the farmer which helps him think of ways to optimally manage agricultural land. Competent farmers with technical and managerial abilities and have quality knowledge of their work, such as understanding planting and harvesting times, use of fertilisers, agricultural tools, land conditions, and their level of suitability (Manyamsari, 2014; de Souza Mello Bicalho & Trippia dos Guimarães Peixoto, 2016). This competency results from knowledge, skills, attitudes, and values, reflected in how to think and act (Baartman & de Bruijn, 2011).

Capital

Capital helps farmers increase dryland agricultural production (Made & Made, 2021). Government support related to this capital significantly affects how farmers manage land to produce cassava. However, farmers in the dryland experience capital difficulties. Farmers' agricultural yields therefore could be more optimal in quality and quantity.

Problems related to capital are experienced by dryland farmers where most people in dryland are not financially well off. This is supported by data from the Indonesian Central Statistics Agency in 2016, found 27.7 million poor people in Indonesia, of which 21.8% were farmers (BPS, 2016). Therefore, the capital used by cassava dryland farmers comes from their money and some from loans taken by their family members. They do not dare to apply for loans to financial institutions such as banks or cooperatives. This is because they do not have the collateral needed to be eligible for loans. In addition, they also need help making monthly payments. Cassava farmers consider borrowing from the bank to be complicated, and that there would be significant consequences if they did not pay. The Centre for the Assessment and Development of Agricultural Technology related to farmers' constraints in accessing capital, namely (1) farmers do not have collateral for land certificates, (2) monthly payments by farmers are not by seasonal production cycles (Saputra, 2018).

Farmers need capital in the form of money, sometimes in large amounts. The results of interviews with cassava farmers showed that they needed an easy and fast mechanism for obtaining capital so that it would not be a burden on them when repaying the capital loan. Farmers would use this capital to start their farming businesses and restore the condition of their agricultural land. Managing agricultural land resources is the same as with other industries that require capital and technology to run their business (Pingali, 2012; Hanafie *et al.*, 2018; Nasikh *et al.*, 2021).

Government Role

The government's role is different as the optimal management of dry agricultural land for cassava farmers has its unique challenges. The difference in the challenges can be seen from the uneven distribution of training and counselling the government provides. In essence, this counselling and training should be made available so that the farmers can solve problems related to agriculture that they often faced independently with sufficient knowledge. Thus make the right decisions by considering all the consequences, and constantly evaluating the skills they possessed (Anantanyu, 2011).

However, all cassava farming communities must receive this training and counselling equally. Only a few cassava farmers have participated in extension and training activities and their follow-up programs. This causes only a tiny number of cassava farmers to be able to manage their agricultural land optimally. The existence of this extension and training can improve both the competence and capacity of farmers and form a farming institution for cassava farmers. Thus, increasing the institutional capacity of farmers in line with the agricultural extension (Pradiana & Maryani, 2019; Hasdiansyah *et al.,* 2020) which can increase the competence and capacity of farmers. Agricultural extension must be supported in one way, namely expanding the competence of extension workers in facilitating farmers and strengthening extension institutions optimally (Anantanyu, 2011).

The role of the government is not only to provide training and counselling but also to provide assistance wherever needed. The government's role in helping cassava farmers is to provide simple agricultural tools, quality cassava seeds, and capital from the state of money for land management. This assistance from the government can improve the quality of cassava productivity in the cassava farming centre area.

Sub Elements of Tape Industry (Industrial Business)

The industrial development of a place plays an important role in the development of a region based on its potential, i.e., resources such as human, natural, and others. The home industry sector is one of Indonesia's well-developed small-scale industrial sectors, so it is of particular concern to the government. This small industry can help improve the community's economy (Nurfiat & Rustariyuni, 2018).

The industrial *tape* area in Wringin District is dominated by household-scale to small-scale industries that have been established for at least 10 years. This area is one of the leading base sector areas in Bondowoso Regency, which produces quality *tape* products, dubbed *Tape* City. The quality of the business is determined by the tenure of the company gained from experience, which will affect the expertise of the industrial business actors (Vijayanti & Yasa, 2016). However, this *tape* industry business actor is also experiencing obstacles in increasing his business caused by the following inhibiting factors.

Production Processing Activities

Production processing in the industrial *tape* area in Wringin District is limited due to the technology used. The processing conducted by the *tape* industry still uses traditional methods. This means that the processing process is done manually, and is the controller of the production process itself so that the environmental impact caused is still low (Handoko, 2014). They conduct traditional processing because the capital and labour industry players are still relatively small. This affects the amount of *tape* production which needs to be improved on. This is supported by the production function theory, which states that the amount of production is influenced by capital, technology, and labour used (Wibiseno & Osly Usman, 2015; Parameswara *et al.,* 2019).

Stages of *tape* processing (Figure 3) in this center area goes through several stages, namely (1) peeling the cassava skin, (2) washing the cassava 2-3 times using running water, (3) boiling the cassava for a maximum of 60 minutes, (4) cooked cassava is removed and placed on a bamboo mat to be cooled naturally for 60-90 minutes, (5) yeast is sprinkled evenly, (6) the cassava is transferred to a bamboo basket lined with banana leaves, the top is covered with banana leaves and left for 2 days, and (7) the *tape* is readily distributed to consumers and can last for 7 days.

However, one of the areas in need of improvement in this industrial area is product packaging which is still traditionally wrapped in plastic. This is one of the obstacles in its development, even though other sectors have opted for modern packaging models that attract consumers. The interview results (Mrs. X) found that they did the packaging with improvised materials due to limited capital and a lack of knowledge of modern packaging. These findings can be used as a basis for recommendations to the industry office or private institutions to conduct community empowerment programs related to training in modern product packaging.

Most of these industrial business players also have plans to increase the value of their products by offering more innovative products. They first have a growth capital strategy for the project to be implemented. With more capital, they can buy more raw materials so that production levels increase. If the level of labour

Figure 3: *Tape* production process

productivity is high, then the amount of output of goods produced in the production process will also be more (Jones Zulu *et al.*, 2015; Kazaz *et al.,* 2016).

Product Distribution

The distribution of products in an industry depends on the industry players' marketing network. The product flow forms a product value chain, which starts from input from raw materials to output, namely sales handling (Zamora, 2016; Indriani *et al*., 2020). This *tape* chain flow occurs because of the relationship between the raw material suppliers and consumers. Based on empirical studies, it was found that there are 5 stages in the product chain flow, namely the input stakeholder stage in the form of farmers, production in the form of producers, and the transformation conducted by all processes starting from the process of turning raw materials into products, the trading stage which is the marketing stage to traders or directly sold to retailers/consumers. The consumption stage is the final consumer.

This study found that the flow of product distribution in the Bondowoso *tape* industrial center area has 3 streams, namely the first flow pattern: *Tape* industry - retailers - end consumers, the second flow pattern: *Tape* industry - end consumers, and the third flow pattern: *Tape* industry-stalls/shops-end consumers. In the first flow pattern, final consumers buy *tape* directly from traders who sell it at the roadside or market traders in this industrial centre area (Figure 4).

This product is distributed outside Wringin District, such as Central Java, at most cities in East Java, and Bali Island, by selling them from pickup cars. In the second flow pattern, the final consumer usually buys *tape* directly at the industrial house; most of these final consumers are the people of the closest sub-district, namely Binakal District and Wringin District. The flow pattern of the three *tape* products produced by the *tape* industry is directly purchased by consumers. Most industrial business players sell *tape* products now to several markets, such as the Wringin market, the Bondowoso wholesale market, and the Besuki market in Situbondo Regency.

Most of those who sell *tape* products are mothers (women) (Figure 5). The men oversee the cassava farm, transporting, picking up, or delivering cassava raw materials; some are also farmers.

Government Role

The government plays an important role in developing industries in this central area. This is because the *tape* industry is the leading sector in Bondowoso Regency and is present on a regional scale in East Java. So, the government needs to take an active role in supporting the progress of this industry, which is one of the economic pillars of the Bondowoso Regency community. One of the government's roles is to improve the quality of human resources in this central area. This is because human resources are the driving force of this small industry. After all, the entire process is done manually.

Figure 4: The form of the first distribution pattern

Figure 5: *Tape* sellers from Wringin Market

For this reason, it is necessary to improve the ability and competence of human resources by providing continuous counselling or training. This counselling or training can improve the skills of industrial business actors, especially workers, starting from the selection and procurement of raw materials and the technology used to market it, so that later it can improve the sustainability of the *tape* industry. This is supported by an empirical study conducted that stated that the factors essential for the survival of the *tape* industry in Candibinangun Village, Sukorejo District, Pasuruan Regency included financial help, skills, and experience in managing the *tape* industry (Nurhayati, 2019).

The government's role in improving human resources is inseparable from community empowerment. The government needs to empower the community, especially the *tape* industry business players and the community of the *tape* industry centre area, Wringin District. Rural-based community empowerment must be directed, which means that empowerment is aimed at people who are the target to get adequate assistance. Community empowerment is enhanced by experience and management to improve themselves and their economy (Hasdiansyah *et al*., 2020; 2021). The government, in this case, is also trying to expand the market and improve the quality of *tape* production through community empowerment.

The role of the government is also needed in building policies related to the development of the industry and the area, especially the *tape* industry centre, which is very necessary as the infrastructure needs to be in place to support the *tape* industry process. The development of this infrastructure aims to expand the access of industrial business actors to the outside world so that marketing is also more comprehensive. Government policies focus on the community to develop their potential and open accessibility outside the region to improve their economy and foster and grow small businesses by relevant institutions in developing small industries.

Sub Element of Physical Environment

This element of the physical environment is seen in agricultural land's suitability for cassava plants. Land evaluation is an assessment done which is based on the characteristics of the land by classifying land capabilities according to the purpose for which the land is being used and can later result in the right decisions being taken with regards to providing direction in the service and utilisation of the land (Ritohardoyo, 2013; Karthikeyan *et al.*, 2019). For this reason, land evaluation is necessary to ensure that the land is being used optimally in an area by considering the surrounding community's physical, social, and economic aspects. Aspects of the conservation of physical resources (environment) are also considered for sustainability in the future.

However, the reality is that there are obstacles in managing dryland that is being experienced by the cassava farming communities in the central area. These constraints are caused by low rainfall of < 500 mm/year, shallow inadequate soil depth of less than 100 cm, low P_2O_5 nutrients, steep slope conditions (> 30%), and the amount of rock on the surface (more than 5%). It can be concluded that the low level of land fertility, low rainfall, and steeper slope topography have resulted in the ability to grow cassava plants being below optimal levels. Hence, the productivity level of cassava is low in dryland around the industrial centre area of Bondowoso Regency.

There need to be efforts to improve the drylands to use for agriculture. This is supported by Liebig's statement about the law of minimum approach, in which actions are needed to improve the limiting factors in the land so that it is hoped that in the future it will produce optimal cassava plants (Jerz, 2022). These improvement efforts must be appropriate and adapted to the capabilities of cassava farmers, such as farmer competence and financial capacity. This is because dryland management requires low to high-level management, which is closely related to the financial condition of cassava farmers. The higher the management effort, the higher the financial capital required. Land management is divided into several levels ranging from low management levels carried out by farmers with relatively low capital, moderate levels of control carried out by farmers by issuing large amounts of capital and using reasonable technology, as well as high management levels with huge capital and usually carried out by agencies, institutions both government and non-government (private) (Rayes, 2007).

Efforts to improve land management can be conducted by making waterways and inundation systems, adjusting the soil depth by ploughing applying fertiliser, applying mulch, alternating cropping patterns, and clearing the rocks on the surface. The improvement efforts can prevent the loss of nutrients due to erosion and optimally ensure the availability of elements of N, P, and K (Guignard *et al.*, 2017; P.U. *et al.*, 2017; Bashagaluke *et al.*, 2018; Kome *et al.*, 2019; Borrelli *et al.*, 2020).

Sub Element of Institutional

The development of an area is supported by accessibility. This accessibility makes it easier for outsiders to access the site, leading to community and regional interactions. This accessibility can equalize the existing development in each region (Nurhidayani *et al.*, 2019). For this reason, access is one of the most important components of regional affordability.

This accessibility can be seen in the region's physical infrastructure, such as the availability of facilities and existing infrastructure. Physical infrastructure includes roads, markets, terminals, cooperatives, and the market so that this can later determine the marketing results by utilising existing rural resources. This access can be seen from physical infrastructures such as facilities and existing infrastructure, including roads, markets, terminals, cooperatives, and banks. So, it can be said that accessibility is inseparable from the elements of facilities and infrastructure that exist in an area.

Facilities and infrastructure promote regional development by improving the surrounding community's economy. Infrastructure development can enhance the quality of human resources and the economy (Yoshino *et al.,* 2019; Garaika & Jatiningrum, 2020). For this reason, developed or underdeveloped regions can be identified based on facilities and infrastructure, accessibility, community economy, human resources, and regional characteristics (Bappenas, 2016).

Sub Element of Facilities and Infrastructure

Activities are those that are related to community involvement to optimally utilise potential resources to improve the economy and welfare of the surrounding community. The activity in this research is in the form of farmer institutions in an area. The role of farmer institutions is needed as a determinant of the success of agricultural development. However, there are no farmers or business groups in the Wringin District, the centre of cassava farming and the *tape* industry. It is easier for cassava farmers or industrial business actors to obtain training and counselling from government agencies and non-government institutions.

The scale of agricultural businesses that are still simple and traditional, in which the land area for farming is narrow, the level of productivity is low, at least cassava productivity, which has limited infrastructure, difficulty in obtaining capital, no technology, and low capacity of farmers, face obstacles in improving their economic condition. These problems should be resolved jointly among cassava farmers. Farmers' joint activities (group action or cooperation) is important in agricultural development (Mosher, 1968). The togetherness of farmers in their activities is more effective in achieving common goals via farmer institutions. The existence of farmer institutions can make it easier for the government or other stakeholders to facilitate reinforcing farmers' (Anantanyu, 2011). Through counseling and training farmers, it is hoped that they can improve their competence as farmers.

Cassava farmers who stand alone or without cooperation between individuals can result in a low individual production capacity. The farmer's capacity is the ability the farmers possess to conduct agricultural activities and is used as a requirement for superior farmers. For this reason, an agricultural institution is needed to oversee cassava farmers' movements. The existence of cassava farmer institutions can help farmers in (1) increasing technical and technological knowledge continuously, (2) being able to compete openly, (3) increasing farmer cooperation in the efficient use of farmer resources, (4) working together to solve agricultural problems (Anantanyu, 2011).

Based on the three elements above, optimising the central area in the Bondowoso Regency must be supported by the physical and social aspects of the surrounding community. The linkage of physical and social aspects included in these three elements (assets, accessibility, and activities) must work together to support the development of an area with a leading sector (Figure 8). This is also useful for improving the community's economic value in the dryland, which incidentally consists of poor people (Smith *et al*., 2009). The linkage of the two aspects in the elements of assets, accessibility, and activities can be used to design the Dryland of Cassava Model to support the central area of Bondowoso Regency.

Dryland of Cassava Model Design for the Central Area of Bondowoso Regency

The design of the cassava cultivation area management model results from a modified development of the Triple-A model and Kendall's Tau model. This Triple-A model on the elements of cassava farmers emphasises the primary natural resources in their product, based on sustainable livelihoods. The design of this cassava farming area management model is expected to optimise the *tape* industry in Wringin District as a *tape* centre area in Bondowoso Regency. The design model for the management of cassava farming consists of elements of cassava farmers, the *tape* industry, the physical environment, accessibility, and activities.

Dryland of Cassava Model for Industrial Optimisation in the *Tape* industry centre area in Wringin District. This model modifies the Triple-A model and Kendall's Tau model. This Triple-A model consists of assets, accessibility, and activities using a sustainable livelihoods approach. This approach is used to sustain community life with limited potential. The condition of the community in the *tape* industry centre area where the land in use is dryland was bad. The concept of sustainable livelihoods can support optimising dryland with cassava plants for existing industries.

Based on Figure 6, the five sub-elements are explained as the basis for the conceptual design of dryland management in cassava centre areas which is based on the theory of sustainable livelihoods. The condition of farmers with low capital, use of technology, competency, and participation in training or counselling, coupled with dry land conditions that need to be improved, affect the quality and quantity of cassava produced. The low level of cassava productivity in this industrial centre area affects the sustainability of the existing tape industry. However, the condition of the industry, which is still processing cassava traditionally, will exacerbate the sustainability of this industrial sector in the future. In addition, the sustainability of the *tape* industry is also seen from accessibility, which is in the form of the availability of infrastructure to support the development of industrial centre areas. However, this low infrastructure level affects the marketing and distribution of tape production to other regions. This must also be supported by aspects of activity (institutional) from the government and non-government.

Thus, the factors of farmers, industry, and the physical environment of dry land (assets), infrastructure factors (accessibility), and institutional support factors (activities) can be used as basic concepts in a conceptual model with several limitations.

The Dryland of Cassava model consists of five important elements for food crops in the form of cassava to optimise the *tape* industry in Wringin District, which is famous as the *Tape* industry centre Area in Bondowoso Regency. These 5 elements consist of farming, the *tape* industry, the physical environment (environment), facilities and infrastructure, and interrelated institutions; have achieved optimisation of the cassava agricultural area and the *tape* industry. The 5 elements in the Dryland of Cassava Model are in a mutually binding relationship that forms an inseparable system.

The environmental aspect is seen in the agricultural land's suitability for cassava plants. In contrast, the human element is based on the business actors of the *tape* industry's access to facilities and the infrastructure of agricultural institutions. The good governance theory proposed requires good cooperation and constructive collaboration between the government sector that establishes regulations and the community sector, which offers self-help activities to increase the efficiency and effectiveness of economic productivity.

The results of data analysis with modified analysis of Kendall's Tau Model and Triple-A Model, the Dryland of Cassava Model, are obtained as follows:

Dryland of Cassava Model
= f (Farming Business + *Tape* Industry + Physical + Infrastructure + Institutions)

The higher the element (f) of farming, the *tape* industry, the more appropriate the land management (physical), the more complete the facilities and infrastructure, and the better the existing institutional management, the more optimal the agricultural cultivation area in supporting the industry in the central area.

These 5 elements are the factors that play an important role in supporting the optimisation of the industry's sustainability in the central area, which is the leading sector of the region. This model is expected to increase the community's welfare, especially cassava farmers, so they can sustain their livelihoods. Farmers and business actors in the *tape* industry have a vested interest in improving their economic conditions. This is like the rational choice theory, which states that actors (farmers and industrial entrepreneurs) determine an action according to their ability to think logically and rationally to achieve their goals and interests. This can later be used to improve the regional economy.

Based on the evaluation of the optimisation of the cassava farming area, it was found that the elements of land suitability (physical), the availability of facilities and infrastructure, and institutions need to be improved to be more optimal. For this reason, the Dryland of Cassava Model also needs to be supported by the government for all elements in this agricultural cultivation area in Wringin District as a *tape* industry centre area. A part of government that is directly related to farming, namely cassava farmers and business players in the *tape* industry in the *tape* industry centre area of Wringin District. The role of the government toward cassava farmers is related to several elements, such as access to capital and markets. The government's contribution to capital is such that they provide capital with low-interest rates to cassava farmers and existing *tape* industry business actors.

Regarding the market, the government must also provide a particular need for cassava so that intermediaries, industry players, and consumers can directly buy from the cassava market. The government should also offer a special place for *tape* souvenirs and other processed products so consumers can buy them easily. The government, in this case, is the institution to help farmers and business actors in the *tape* industry sell cassava

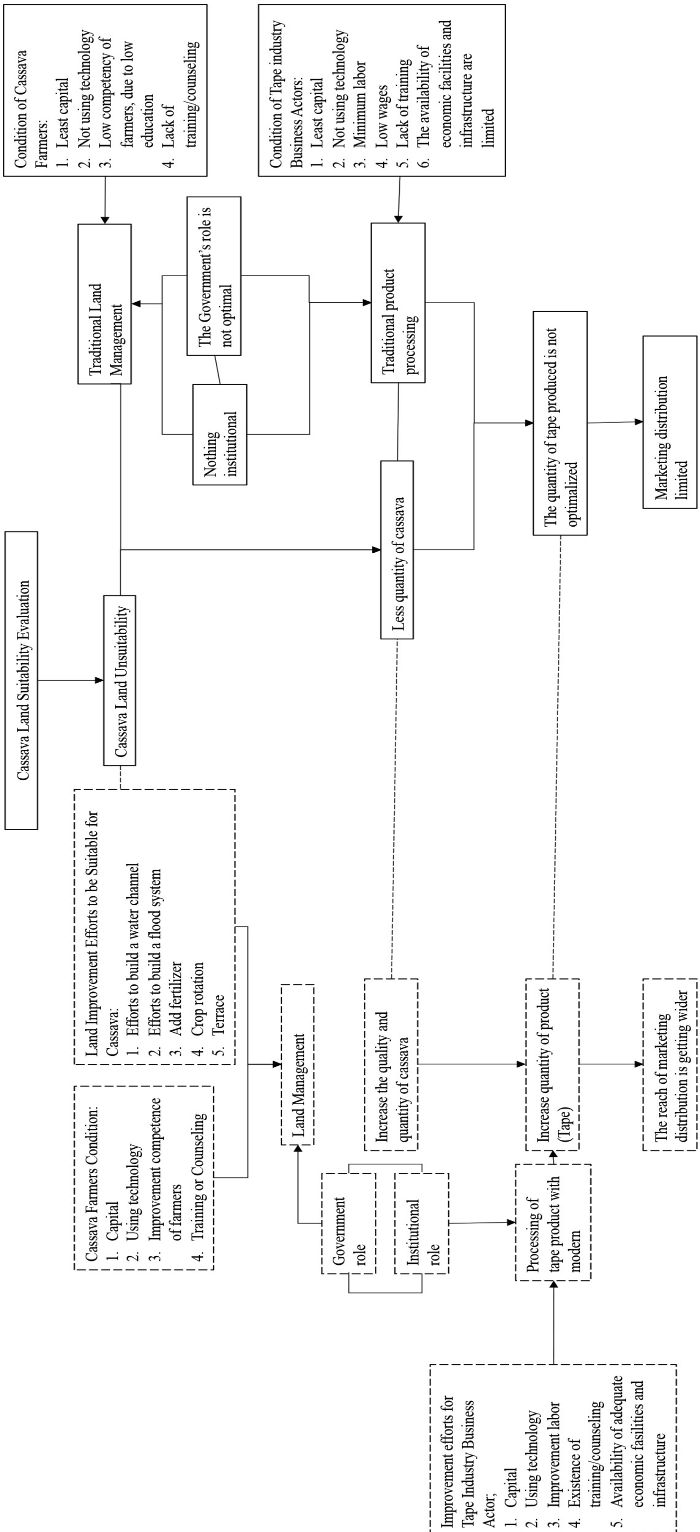

Figure 6: The relation of aspects to conceptual design

and its processed products in the form of *tape*. Another government effort is to maintain the Bondowoso Regency icon as a *Tape* City by holding *tape*-related events such as exhibitions of *tape* and other processed products.

Conclusion

Dryland management requires more skill because the land has low nutrients and expensive management costs. Farmer competence regarding knowledge and management of dry land agriculture is one of the main factors in land productivity. The findings of this research are that the dryland of cassava model design which is modified from the design of Kendall's Tau model, and the Triple-A model and is based on sustainable livelihoods. The dryland of cassava model design includes three aspects, namely (1) assets consisting of farmers, industrial business actors, and agricultural land; (2) accessibility includes the availability of supporting facilities and infrastructure in dryland areas; and (3) activities that include government institutions and roles. These three aspects are closely related and cannot be separated in dryland management so that it can improve the surrounding community's economy. Dryland of Cassava Model = f (Farming Business + *Tape* Industry + Physical + Infrastructure + Institutions), which means that the higher the element (f) of farming, the *tape* industry, the more appropriate the land management (physical), and the more complete the facilities and infrastructure and the better the existing institutional management, the more optimal the agricultural cultivation area in supporting the industry in the central area.

The limitation of this research is that it was conducted on dry land with specific cassava production and additional tape management. However, the model design illustrates how the ecosystem of dry land resources and downstream products in one area will provide more benefits for the community. For this reason, it is recommended that further research be done to try this design on other downstream products in one integrated area to provide a variety of superior products according to a region's potential. This research implies that an active role by the government and non-government institutions is needed to support the community in its regional development, especially in Wringin District as it is the centre *tape* industry area in East Java.

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