

Full Length Research Paper

Sustainable dryland management strategy in Buleleng Regency of Bali, Indonesia

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The research objective was to formulate a sustainable dryland management strategy in Buleleng Regency, Bali Province. The results showed that the effective strategies were namely: (1) Utilizing available dryland to increase the quantity and quality of agricultural production; (2) Utilizing the research results of research institutes of the Ministry and University related to dryland; (3) Attracting investors to invest in the use of dryland, strengths-threats (ST) strategies; (4) Rearranging of inheritance of agricultural land to avoid narrowing agricultural land owners; (5) Application of agricultural technology 4.0 to attract millennials to work in agriculture; the weakness-opportunity (WO) strategy, (6) Increasing the productivity of dryland by applying technology produced by ministerial research institutes and University, (7) Increasing the availability of facilities and infrastructure to support dryland development, such as making jubang, drip irrigation, etc. (8) Increasing capital and facilitating access to capital, and market networks and partnership systems; The WT strategy, (9) Implementing the Perpetual Land Law to prevent land conversion for non-agricultural purposes, and (10) Improving the quality of farmers' human resources through trainings, so that farmers have the ability to take advantage of existing technology.

Key words: Sustainable, dryland, strategy, management, strengths-opportunity (SO), strengths, weaknesses, opportunities, threats (SWOT).

INTRODUCTION

Sustainable upland management is an agricultural system that utilizes dryland resources to produce food and income of the management farmers, to meet the needs of human life without lowering the quality of land resources and the environment, so that the resources of dryland can be utilized sustainably by the next generation. According to Abdurachman and Sutono (2005) and Arsyad (2010), the implementation of sustainable agricultural systems should be environmentally, technically, economically, and socially feasible. According to Mallikarjunarao et al. (2015) dry land agriculture is the cultivation of crops in areas with an

annual rainfall of less than 750 mm.

Dryland in Indonesia is still widely available around 12.90 million hectares which has not been intensively attempted to increase agricultural production (Idjudin and Marwanto, 2008). Management of the dryland properly and sustainably is currently and urgently needed to be applied, given that there has been a lot of land degradation, therefore it is necessarily proper and targeted on land management technology (location specific) in accordance with the sacredness (quality, characteristics) of the relevant land resources (Utomo, 2002; Kurnia et al., 2004; Endriani, 2010). According to

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Sukirno (2013), the production rate of the agricultural sector is heavily influenced by factors that are beyond the ability of farmers to control it. The agricultural sector in Indonesia is still affected by climate, rainfall, and the availability of irrigation water, so the agricultural sector needs to be managed properly, as well as management strategies in its management system. According Yuvraj et al. (2017) dry lands contribute 42% of the total food grain production of India. These areas produce 75% of pulses and more than 90% of sorghum, millet and groundnut from arid and semi-arid regions. Thus, dry lands/rain fed farming plays a dominant role in agricultural production. This target cannot be realized from irrigated areas alone as the irrigation potential is only for 178 million hectares. Therefore, an appropriate technology has to be developed for dry land farming. Due to dependency on rains the sowing is often delayed in dry land area which substantially reduces the yield of crop. A water application mechanism thus designed and developed wherein the water will be given to the seed at the time of sowing. This will help farmer to sow crop on time, which will help to increase the production by attaining proper germination of crop at the time of sowing.

Future dryland development has greater opportunities than rice fields because: (1) can be developed as a mainstay commodity, (2) support food security programs, (3) spur regional and national economic growth, (4) alleviate poverty and open up jobs in the Countryside (Suriadikarta et al., 2002). Meanwhile, according to Pradana et al. (2013), although the potential for dryland development is considerable, that dryland has a more fragile agroecosystem, is lagging and less developed and gets less serious attention from the government compared to the agroecosystem of rice fields. Dryland in order to be empowered for sustainable agricultural development, sustainable land management is needed in accordance with its capabilities and suitability. This means not only to improve the quality or productivity of land and the quality of environmental resources, but also to improve the welfare of the community and the economic growth of the region.

In an effort to utilize and increase the productivity of dryland in a sustainable manner in Buleleng Regency, Bali Province, a management strategy or tactic is needed, which in this study uses the SWOT analysis method. According to Grant (2020), SWOT analysis is designed to facilitate a realistic, fact-based, data-based display of the strengths and weaknesses of an organization, or industry. Meanwhile, according to Shewan (2020), SWOT analysis is a technique used to determine the strengths, weaknesses, opportunities and threats of a company or organization, or individual projects within a department. However, according to Rangkuti (2018), SWOT analysis (Strengths, Weaknesses, Opportunities, Threats) is a tool to formulate strategies or tactics for the development of a product, institution, area by recognizing internal conditions in the form of strengths

and weaknesses. External conditions, in the form of opportunities and threats are to be faced, in order to achieve organizational goals. Based on the combination of the four sets of factors, several strategic alternatives are obtained. SO (Strengths-Opportunity) strategy is obtained by thinking of ways that can use strength to take advantage of existing opportunities. ST (Strengths-Threats) strategy looks at the strengths an individual have to avoid in the threats faced. The WO (Weakness-Opportunity) strategy is designed to take advantage of existing opportunities by overcoming various existing weaknesses. The WT (Weakness-Threats) strategy is a defense strategy to minimize weaknesses and avoid threats. The SWOT analysis has been applied by Sri Sumarniasih and Antara (2020) to formulate a strategy and to maintain Food Security in Bali Province. However, Nurdin (2011) formulated a dryland use strategy in the Limboto River Basin, Gorontalo Province, not using a SWOT analysis, only based on facts and field problems. Likewise Matheus et al. (2012) formulated a dryland agricultural management strategy to increase food security in East Nusa Tenggara without a SWOT analysis.

Buleleng Regency is located in the Northern Hemisphere of Bali Island, with a very diverse topography, ranging from lowlands, hills, and mountains. Hilly and mountainous areas stretch across the south, while in the north along the coast it is lowland. Judging by the morphological or topographical condition of Buleleng Regency, approximately 70,226.0 ha (51.41%) is a ramp, some 21,462.75 ha (15.71%) 32,634.50 ha (23.89%) steep terrain. Remaining 12,264.75 ha (8.98%) flat area. The dryland farm area is an area of 2,140.89 ha located in Banjar, Seririt, Gerokgak, and Kubutambahan sub-districts. Dryland with low productivity must be managed well by increasing productivity. Therefore, research of dryland management strategy in Buleleng Regency is necessary. The purpose of the research is to formulate the dryland management strategies in Buleleng Regency, which are still widely available for use.

RESEARCH METHODS

Location

The research site is in Buleleng Regency of Bali Province which has a dryland agricultural area of 2,140.89 ha, spread across Banjar, Seririt, Gerokgak, and Kubutambahan sub-districts. Only about 50% of the dryland is newly utilized and even though productivity is still low, the remaining 50% is untapped and left as empty gardens and cattle grazing sites (Figure 1).

Data

The types of data collected in this study are quantitative data such as dryland area, dryland that has been utilized, dryland productivity, and qualitative data among others internal and external factors of dryland in Buleleng Regency. The data source is a secondary



Figure 1. Map of Bali Island.
 Source: <https://images.search.yahoo.com/search/images-Peta-Buta-Bali1024x708.jpg&action=close>.

source producing secondary data collected from related agencies such as the Department of Agriculture and Plantation of Buleleng Regency, Buleleng Planning Regency, and primary sources that produce primary data checking directly into the field concerning the existence and condition of dryland in Buleleng Regency. The method of data collection is direct observation to the field, and interviews with officials at related agencies in Buleleng Regency.

Variables

The types of variables in this study are internal conditions consisting of strength and weakness factors, and external conditions consist of opportunity factors and threat factors in dryland management in Buleleng Regency.

Data analysis

The survey method is used to obtain biophysical data and observations for interviews with farmers. The stages carried out in analyzing SWOT so that the decisions obtained are more precise, namely:

1) the stage of data retrieval namely; the identification of external and internal factors, 2) the stage of analysis that is the creation of internal-external matrix and SWOT matrix, and 3) the strategy formulation stage is to combine strength factors, weakness, opportunity and threat, so that four combination strategies are obtained, (1) SO strategy (Strengths Opportunities) is a strategy used to harness strengths opportunities, (2) ST Strategy (Strengths Threats) is a strategy used to utilize strengths and to overcome

threats ,(3) WO Strategy (Weaknesses Opportunities) is a strategy used to minimize weaknesses and to take advantage of opportunities, (4) Strategi WT (Weaknesses Threats) is a strategy used to minimize weaknesses and avoid threats in dryland management in Buleleng Regency.

RESULTS

Analysis of internal and external condition of dryland in Buleleng Regency

Internal condition analysis of dryland in Buleleng Regency

Strength factors: (1) Dryland is still widely available, (2) Has high biodiversity, (3) The willingness of farmers is very high in increasing the productivity of dryland, (4) Has average rainfall from low to high, (5) Has topography from flat to steep

Weakness factors: (1) Low dryland productivity due to nutrient poorness, (2) Low farmer income, (3) Low and elderly farmer education, (4) Weak managerial capabilities of farmers, technical and appropriate technology at the farmer level, (5) Limited facilities and infrastructure supporting dryland development, (6) Weak desecration, and access to capital, market networks and partnership

systems to improve farmers' bargaining position.

External condition analysis of dryland in Buleleng Regency

Opportunity factors: (1) The development of research institutions of ministries and universities that are concentrated in the development of agricultural technologies and resources, (2) The increasing need or demand of the community towards agricultural commodities, (3) The greater interest of investors in agribusiness, (4) The market share of agricultural products is increasingly widespread.

Threat factors: (1) The transfer of land functions to share interests, (2) The narrower the area of agricultural land, (3) The reduced interest of the younger generation to work and strive in agriculture, and (4) The competition of capital market agricultural products is quite high.

Strategy formulation with SWOT Matrix

As revealed in the research method, the formulation of dryland management strategy in Buleleng Regency used SWOT matrix, after internal and external condition factors of dryland are identified, as presented in Table 1.

Description

1. SO strategy (Strengths-Opportunities) is a strategy to harness strength and take advantage of opportunities.
2. ST strategy (Strengths-Threats) is a strategy of utilizing strength to overcome threats.
3. WO strategy (Weaknesses-Opportunities) is a strategy to minimize weaknesses to take advantage of opportunities.
4. WT strategi (Weaknesses-Threats) is a strategy to minimize weaknesses to avoid threats.

DISCUSSION

Dryland management strategy in Buleleng Regency

SO Strategies (Strengths-Opportunities)

SO Strategy (*Strengths- Opportunities*) is a strategy used to achieve the greatest opportunities in relation to the management of dryland in Buleleng Regency of Bali Province, among others:

1. Utilizing available dryland to increase the quantity and quality of agricultural production: Buleleng District Agriculture Office has recorded an area of dryland in

Buleleng Regency reaching 45,000 ha, and only about 30,000 ha is utilized by farmers to grow secondary crop (palawija) such as corn, beans and horticultural crops such as mangoes. Dryland that is still widely available in Buleleng Regency should be utilized to increase the quantity and quality of agricultural products to meet the growing needs of human life. Therefore all efforts to utilize dryland must be made and all necessary costs must be allocated both by the owner's farmer and by the government as a development agent in a region.

2. Utilizing the research results of ministry and PT research institutes related to dryland: Ministry of Research Institutions and Universities (PT) are centers of innovation and technological findings, especially innovation and agricultural technology. In order to manage dryland, the results of innovations and technological findings must be utilized to increase dryland productivity. For example conservation technology that corresponds to specific locations to maintain and improve the quality of agricultural products, intercropping (*tumpagsari*) that are in between mango crops planted seasonal crops such as beans, corn etc., so as to increase people's income.

3. Attracting investors for investment utilizing dryland: The demand for agricultural commodities, which tend to increase in line with the increasing population, has opened up opportunities for farmers and farmers to increase agricultural production that has economic value and is suitable to be developed in dryland that is still widely available in Buleleng district. Farmers with limited capital can work with agricultural entrepreneurs or outside investors to invest in dryland agribusiness. For example, agribusiness investments in wine, mango and other types of commodities in Banjar district, Seririt, Gerokgak, and Tejakula District. Agribusiness investment of this fruit plant can move from the provision of production facilities (off-farm-upstream), cultivation (on-farm) to processing production into processed products (off-farm-downstream). This investment really promises a very decent return for interested investors.

ST Strategy (Strengths-Threats)

ST Strategy (*Strengths-Threats*) is a strategy used to force and to overcome threats in dryland management in Buleleng Regency, Bali Province, among others:

1. Arrangement of devolution of agricultural land to avoid narrowing the ownership of agricultural land: The current devolution system in Bali is to divide the land of parents by as many as their sons. This system has caused the control of farmland to narrow. A farmer with four children controls about 2 ha of land. When the parents are gone, then with the inheritance system for the

Table 1. SWOT Matrix "Sustainable Dryland Management Strategy in Buleleng Regency of Bali Province".

<p style="text-align: center;">Internal</p> <p style="text-align: center;">Power (<i>STRENGTHS, S</i>)</p> <ol style="list-style-type: none"> 1. Dryland is still available quite widely 2. Has high biodiversity 3. The willingness of farmers is very high in improving the productivity of dryland 4. Has average rainfall from low to high 5. Has topography from flat to steep 	<p style="text-align: center;">Weakness (<i>WEAKNESSES, W</i>)</p> <ol style="list-style-type: none"> 1. Low dryland productivity due to nutrient poor 2. Low farmer income 3. Education of low and elderly farmers 4. Weak managerial capabilities of farmers, technical and appropriate technology at the farmer level. 5. Limited facilities and infrastructure supporting dryland development 6. Weak advertising and access to capital, market networks and partnership systems to improve farmers' bargaining position.
	<p style="text-align: center;">External</p> <p style="text-align: center;">Opportunities (<i>OPPORTUNITIES, O</i>)</p> <ol style="list-style-type: none"> 1. The absence of research institutions of ministries and universities that concentrate in the development of agricultural technologies and resources. 2. Increasing needs or public demand for agricultural commodities 3. The amount of interest of investors in agribusiness 4. Wider market share of agricultural products
<p style="text-align: center;">Threat (<i>THREATS, T</i>)</p> <ol style="list-style-type: none"> 1. The transfer of land functions to share interests 2. The narrower the area of agricultural land 3. Reduced interest of the younger generation to work and strive in agriculture 4. High competition for agricultural products capital market 	<p style="text-align: center;">STRATEGY-ST</p> <ol style="list-style-type: none"> 1. Arrangement of devolution of agricultural land to avoid narrowing the ownership of agricultural land (S1, S2, S3, S4; T1, T2) 2. Application of agricultural technology 4.0 to attract the interest of millennials working in agriculture (S1, S2, S3, S4; T1, T3)
	<p style="text-align: center;">STRATEGY-WO</p> <ol style="list-style-type: none"> 1. Increase dryland productivity by applying technology produced by Ministerial Research Center and University (W1; O1, O2, O3, O4) 2. Procurement of facilities and infrastructure supporting dryland development, such as <i>Jubang</i> Manufacturing, drip irrigation, etc. (W3, W4; O1, O2, O4). 3. Increase capital and facilitate access to capital, and market networks and partnership systems (W5; O1, O2, O3, O4)
	<p style="text-align: center;">STRATEGY-WT</p> <ol style="list-style-type: none"> 1. Apply the Perpetual Land Act to prevent the transfer of land functions for non-agricultural purposes (W1, W2, W3; T1, T2) 2. Improving the human resources quality of land farmers with trainings, so that farmers have the ability to utilize existing technology (W3, W4; T1, T2, T3, T4)

Source: Primary Data. SWOT Concept adapted from Rangkuti (2018), Grant (2020), and Shewan (2020).

children, finally the mastery of farmland by the children of farmers is only about 0.5 ha. An area of just 0.5 ha is not enough to support the family, and if this land is located around the city or suburbs it ends up being sold for non-agricultural provisions. Unlike in Japan, an area of farming worthy of the life of one family must be maintained with a prohibition on dividing farmland by the

children of farmers. If parents can no longer afford to be farmers, then agricultural land should only be passed down entirely to the smallest children, and other children should look for work outside the farm, for example in the industry, therefore, to maintain the area of agricultural land including dryland, the current devolution system in Bali must be made arrangements. Although not

exactly the same as in Japan, at least the arrangement leads to maintaining an area of farming on an economic scale. It means an area of land that is able to prosper its owner.

2. Application of agricultural technology 4.0 to attract millennials working in agriculture: The stigma of negative farmers and agriculture,

such as not promising a future, hard work, dirty mud-sludge, heat-ups at work has made farmers and agriculture less in demand by millennials. Millennials are more interested in white color jobs and indoors. While working in agriculture is blue color job and working outdoors. Farmers in Indonesia generally and in Bali in particular are elderly people, average over 60 years, a productivity age begins to decline. To attract millennials working in agriculture, technology that is familiar to millennials is digital technology in agriculture, which is nothing but agricultural technology 4.0. The government cq Ministry of Agriculture can create a demonstration plot (demplot) application of agricultural technology 4.0 in each province, which can be a direct example for millennials in agriculture, including dryland farming.

WO Strategies (Weakness-Opportunities)

WO strategy (Weaknesses Opportunities) is a strategy used to minimize weaknesses and achieve peluang in managing dryland in Buleleng Regency of Bali Province, among others:

1. Increasing dryland productivity by applying technology produced by Minestrial Research Center and University: The availability of dryland in Buleleng Regency is still quite wide, but productivity is still relatively low due to various factors, such as low knowledge and skills of farmers, limited farmer capital, and limited application of dryland conservation technology, etc. In an effort to increase the productivity of dryland, it can apply innovations and technologies found by ministry research institutions and PT.

For example, applying conservation technology and applying drip irrigation in relation to water saving, planting seasonal crops and horticulture of high economic value with intersping systems. Karunakaran and Behera (2015) confirming that conservation agriculture is an important component of the overall strategy for enhancing productivity, improving environmental quality and preserve natural resources for food security and poverty alleviation. Soil tillage is one of the fundamental agro-technical operations in agriculture because of its influence on soil properties, environment and crop growth. Since continuous soil tillage strongly influence the soil properties, it is important to apply appropriate tillage practices that avoid the degradation of soil structure, and maintain crop yield as well as ecosystem stability.

Dryland farming techniques includes water conservation, increase water absorption, reducing the loss of soil moisture, bunding and terracing, contour bunding, mulching, intercropping, precision agriculture, use of drip irrigation facilities and use of growth regulators and chemicals. Choice of varieties is important. Varieties which have proven excellent in irrigated areas are

generally unsuited for dry land conditions.

Many attempts at dryland farming have failed, largely due to lack of recognition of the requirements for the variety selection. Variety requirements for dry farming are short-stemmed varieties with limited leaf surface minimize transpiration, deep, prolific root systems enhance moisture utilization and quick-maturing varieties are important in order that the crop may develop prior to the hottest and driest part of the year and mature before moisture supplies are completely exhausted.

2. Procurement of facilities and infrastructure supporting dryland development (example *jubang* manufacturing, drip irrigation, etc.):

The main limit of dryland management is the availability of water. The main water source of dryland is the rainy season, which falls six months of the year, so it can only grow in the rainy season, and it is common for planting system on dryland to be rainy. When the rainy season is indeed abundant water and excess water seeps into the soil. Excess water in the rainy season needs to be accommodated for use during the dry season. Therefore, there needs to be facilities and infrastructure supporting the development of dryland such as Jubang or large tubs of rainwater containers, so that the water produced by this landfill can be used for irrigation in the dry season, such as drip irrigation, watering crops, drinking livestock, etc.

3. Increasing capital and facilitating access to capital and market networks and partnership systems:

The income of farmers in general and dryland farmers in particular is relatively low, which is only sufficient to meet the needs of food, clothing, and shelter which affects the low capital stock they have. This implies that farmers are unable to afford production facilities, provision of supporting infrastructure for dryland development, and application of technology, resulting in low dryland productivity. The solution to this problem is to increase capital and facilitate access to capital for farmers or dryland investors to source for capital, be it sub-district banking, Village Unit Cooperatives, or Village Credit Institutions.

Thus this solution will be able to empower dryland farmers, in the end and their land productivity will increase. If farmers or dryland cultivators are successful in increasing land productivity with a variety of vegetable and fruit products, it is also necessary to create market networks and partnerships with retailers in urban areas, such as supermarkets or retailers in public markets.

WT Strategy (Weaknesses-Threats)

The WT (Weaknesses Threats) strategy is a strategy used to minimize weaknesses and avoid threats in dryland management in Buleleng Regency, Bali Province, including:

1) Implementing the Perpetual Land Law to prevent land conversion for non-agricultural purposes:

The conversion of land functions, including dryland for non-agricultural purposes, is taking place massively, especially in urban and out-of-town areas in Bali Province. If this land conversion continues without being hindered, it is feared that agricultural land in Bali will become increasingly narrow, while land is the main production factor in the food production process. So land conversion is a threat in increasing food production needed by an increasing population. In order to inhibit or minimize land use change, there is an already Eternal Land Law, but its application is very weak. Therefore, the perpetual land law must be strictly enforced by imposing sanctions on violators.

2. Improving the quality of human resources for dryland farmers with trainings, so that farmers would have the ability to utilize existing technology:

The relatively low quality of human resources for dryland farmers is indicated by the low knowledge and skills of farmers in adopting and applying technology which has an effect on increasing the productivity of their land. Therefore, it is important to improve the quality of the human resources of dryland farmers by increasing their knowledge and skills in adopting and implementing dryland technology. This can be done through counseling and information, so that they are familiar with, the attitudes, and are ultimately willing to adopt and apply dryland technology.

Education through counseling and introducing new things must be carried out continuously so that there will be a change in the mental attitude of farmers and ultimately responsive to new technologies related to dryland. Even though there are social media with a lot of content that contains technology related to dryland, correct direction and explanation by government officials or agricultural extension agents still need to be done.

Conclusion

The dryland management strategy in Buleleng district, namely: the SO strategy is (1) Utilizing available dryland to increase the quantity and quality of agricultural production, (2) Utilizing research results from research institutes of the Ministry and Higher Education (PT) related to dryland, (3) Attracting investors to invest in using dryland. ST's strategy is (1) rearranging the inheritance of agricultural land to avoid narrowing agricultural land owners, (2) Application of agricultural technology 4.0 to attract millennial generation to work in agriculture. The WO strategy is (1) Increasing the productivity of dryland by applying technology produced by research institutes of the Ministry and PT, (2) Increasing the availability of facilities and infrastructure to support dryland development, such as making *jubang*, drip irrigation, etc., (3) Increasing capital and facilitate

access to capital, and market networks and partnership systems. The WT strategy is (1) Implementing the Perpetual Land Law to prevent land conversion for non-agricultural purposes, (2) Improving the quality of farmers' human resources through trainings, so that farmers have the ability to take advantage of existing technology.

Recommendations

In the effort to manage dryland in Buleleng Regency, which is still widely available, stakeholders such as farm owners, officials from the Agriculture and Plantation Agency, non-government organizations, and investors should implement the strategies formulated in this study, and continue to describe each strategy into a program and, activities (action plans) in accordance with the available budget. By implementing this strategy, it is hoped that the productivity of dryland in Buleleng Regency will increase, and in the end the welfare of farmers who live in dryland will increase.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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