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TAY JUHANA FOUNDATION

Suboptimal Land Series - Part 6 (Final)

Food Security and Climate Change Adaptation in Dryland Agriculture

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- Dryland farming is important as it provides a globally important ecosystem, source of livelihood for 2 billion people, and is vulnerable to climate change.
- Many regions have been facing crop failure that leads to death due to longer drought; which will be repeated under the worsening climate change. As a result, food insecurity will become more prevalent in the future.
- Improvement in cropping methods such as adopting water conservation techniques and drought tolerant varieties would strengthen food security.

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Why Drylands Matter to Human and Food System

Drylands are home to over 40% of the human population in Africa and Asia, and to between 25–30% of the rest of the world's population that equals to around two billion people (Reynolds et al. 2007). They rely directly on dryland ecosystem services for daily survival, whether through rain-fed or irrigated farming, or through widespread pastoralism. Globally, there are 6.1 billion hectares of drylands which generally consist of barren land (28%), grasslands (25%), forest (18%), croplands (14%), and other wooded land (10%). Not only important to human livelihood, they are also essential for the global ecosystem since a quarter of the world's forests are located in drylands (FAO, 2019). The spread of dryland systems can be seen in Figure 1.

How Climate Change Affects the Food Security in Dryland Area

The IPCC 2021 Report on Climate Change has implied a code-red for humanity. It outlined the worsening climate impact in every region of the planet. The rising temperature of 1.5 °C would be only a decade away if no ambitious action takes place (UNFCCC, 2021). Climate change is affecting food security through global warming that changes precipitation patterns, which could create extreme events to dryer or longer droughts. Plants need water to grow optimally. Lowering water supply through change of precipitation will decrease yield productivity. Observed data showed that the productivity of staple food such as maize, wheat, rice, and sugar beets have decreased over the decades (Ray et al., 2019). Hence, this impact is certainly affecting food security because of disrupted food production and availability.

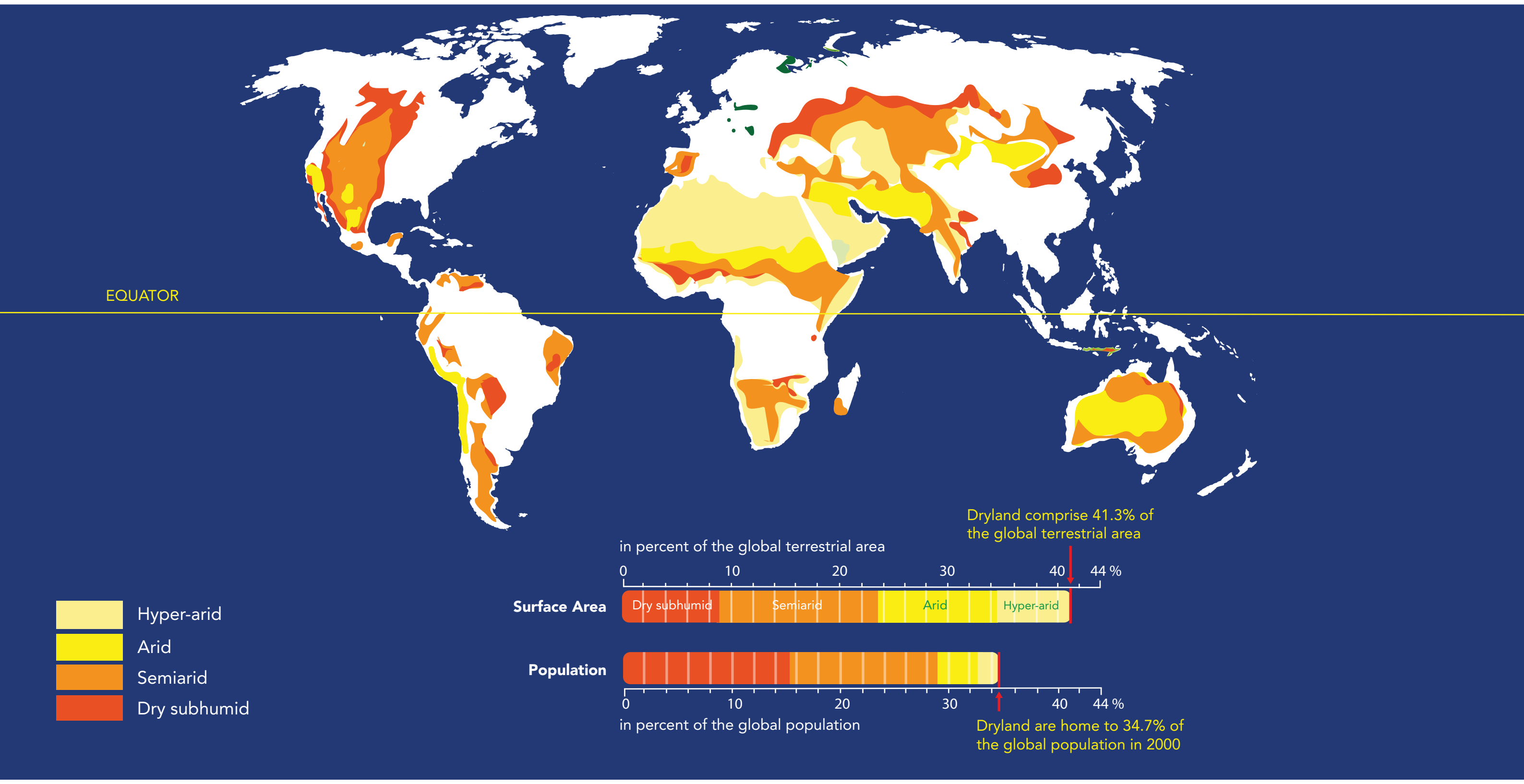

Figure 1. The map of the world's dryland and percentage population who live in dryland. Source: Davies et al. (2015).

Impoverished and vulnerable regions are in the frontline of drought-related food crises. In Madagascar, severe drought and irregular rainfall have led to famine since mid-2021 (Baker, 2021). It is estimated that 1.14 million people fall into food insecurity and 400,000 of them experienced severe hunger; some of them consumed raw cactus, wild leaves, and locusts as food sources. The combination with Covid-19 pandemic has worsened the situation which led to famine. Historically, long droughts are among the key drivers that contributed to the severity of the crisis of many food crises or even famine in the world such as the 2005–2006 Niger food crisis, 2010 Sahel famine, 2011 East Africa drought, and 1983–1985 famine in Ethiopia. Therefore, the development of dryland agriculture would help the affected countries to cope with long drought and water scarcity.

Dryland in Indonesia

Dryland area is indicated with limited water resources and is never inundated by fresh water. Limited water resources controlled by climate condition and elevation from sea level. In Indonesia, a threshold of rainfall below 2,000 mm per year (rainfall <100 mm per month over 7 months a year) is considered as a dry climate condition; above that is categorized as wet climate (Ritung et al., 2015). However, the Food and Agriculture Organization (FAO) identified dryland by annual rainfall below 700 mm; and defined it as desert if the rainfall is lower than 150 mm a year (FAO, 2004). Table 1 shows a comprehensive definition beside the climatic condition, the dryland in Indonesia also connected to the land in higher elevation. In addition, Indonesia also includes soil acidity to acidic dryland group next to dryland in dry climate. With this definition, about sixty percent of land area in Indonesia is categorized as dryland, and one-tenth is dryland in dry climate condition (Mulyani et al., 2016).

Based on the explanation below (Figure 2), the dryland can only provide a small input of water availability, making them suboptimal land that is challenging for agriculture purposes. The land is also low nutrient, acid, and prone to erosion. Some farmers adapt with better water storage and irrigation systems, especially in Indonesia where its dryland is not as dry as the FAO definition. The development of dams with integrated irrigation systems helps to maintain production in longer dry seasons. In Kalimantan, where the area does not have irrigation infrastructure, they utilize rainfed paddy to produce food or plant annual crops.

However, recurrent drought can completely initiate crop failure. Combined with the limitation of soil fertility to support productivity, the dryland area is vulnerable to food crisis and long-term food insecurity especially in the Eastern Indonesia. A research from Riptanti et al. (2020) revealed that dryland farmers in Eastern Nusa Tenggara Province showed a high risk of food insecurity due to uncertain drought and crop failure. Additionally, more than 70% of their farmers rely on local food to satisfy their needs. In another case, two decades ago in 1997, a drought induced by El Nino created a food crisis in Papua (Pardomuan, 1997). It was reported that the casualties have caused 406 people died from food shortage and ailment. In the uncertain condition of climate change impact in future, Indonesia potentially have to face severe experiences. Even in periodic El Nino which lead to longer drought seasons, efforts to minimize the limitation on dryland are not always successful. Crop failures still haunt the farmers. In 2019, the drought in 100 regencies and cities in Indonesia with affected area about 100,746 ha of agriculture and 9,358 ha experienced crop failure (Alika, 2019).

Strategies to Improve Food Production in Dryland

In the dryland area, normal rice farming with inundation (with 4,000-5,000 litres of water per kg of grain produced) will be hindered by water limitation. An effective water management requires irrigation as a method for conserving soil moisture. Soil moisture in the dryland area can be maintained to prevent high evapotranspiration. The Conservation Agriculture (CA) method can be used to improve yield productivity. This technique is compatible with many types of land as a means of agriculture that features little or no soil disturbance, direct seeding into previously untilled soil, crop rotation, and permanent soil cover, particularly through the retention of crop

Table 1. Classification of dryland using elevation, climate, and soil acidity.

Parameter	Classification	Criteria
Elevation	Upland	Elevation < 700 m above sea level
	Lowland	Elevation ≥ 700 m above sea level
Climate (Indonesia)	Wet climate	Rainfall ≥ 2.000 mm per year
	Dry climate	Rainfall < 2.000 mm per year
Climate (FAO)	Dry sub-humid	Rainfall 500-700 mm per year
	Semi arid	Rainfall 250-500 mm per year
	Arid	Rainfall 150-250 mm per year
	Hyper arid	Rainfall < 150 mm per year; desert falls into this category
Soil acidity	Acidic	soil pH < 5.5
	Non Acidic	soil pH ≥ 5.5

Source: FAO (2004), Ritung et al. (2015)

residues (Harrington, 2008). Another method called ley farming can also be used to reduce evapotranspiration and provide nutrients to soil using grass or legume decomposition (Edwards et.al, 2019).

Besides improving farming methods, developing infrastructure (e.g., dams) is necessary to harvest water during rain periods thus maintaining good production in dry climate. Adjusting to a drip irrigation system is also effective in dryland with dry climate conditions. Employing climate-resilient crop varieties will help maintain the yield. The use of efficient water crop varieties will increase resilience in limited water conditions.

Multiple studies have identified cross-breed crops to obtain varieties that can survive in dryer conditions and produce high yield (Schmidt, 2015). Kaihatu et al. (2019) found upland superior rice varieties (Towuti, Inpago 8, Inpago 9, Inpago 10, and Inpago 11) in dry climate of Southeast Moluccas can deliver double yield productivity to 2.03 ton/ha compared to local varieties (1.24 ton/ha). Tesfaye et al. (2018) found combining drought and heat tolerant maize varieties that can maintain maize productivity and food security under climate change, which the varieties have been adopted by local farmers.

Finally, the agriculture sector is both the major source of carbon emission and among the most affected by climate change. This looping condition requires a significant change in current practice to be more sustainable. Collaboration and integration between the relevant stakeholders can resolve problems or minimize the impact of climate change on the dryland (Farooq and Siddique, 2016). The combination of various approaches such as CA, ley farming, irrigation development, and effective stakeholders collaboration will significantly affect the livelihood improvement of 2 billion world's population that depend on dryland ecosystems.

Story from the Field

Source of story: INA-CA (2019).

Abdul Aziz is a farmer in Labuhan Mapin Village, Sumbawa, West Nusa Tenggara, Indonesia—an area with dryland in dry climate conditions. He owns 1.5 ha of land inherited from his father where he produced corn to earn income. In early years, the harvest only produced an average yield of 3 to 4 ton/ha. Sometimes he experiences crop failure from rainfall inconsistency and drought. There was nothing much he could do everytime crop failure hit. "It is a risk to become a farmer," said Aziz. To meet his needs, he sometimes sells his livestock or borrows some money from his family.

However, his life changed after adopting a new agricultural technique. The method is called Conservation Agriculture (CA), which FAO defined as "farming system that can prevent losses of arable land while regenerating degraded lands" (FAO, 2021). CA uses three approaches of minimum mechanical soil disturbance, permanent soil organic cover, and crop species diversification. The method will enhance soil cover that maintains soil moisture for optimal crop growing.

As a result, the new productivity of corn in his field has increased to 6.9 ton/ha. This production was from December 2017 to March 2018 harvest period, even in December where the rainfall was low. "CA gives us new hope and I am happy with this harvest," said Aziz with a big smile on his face.

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ABOUT TJF

Tay Juhana Foundation (TJF) is a nonprofit organization dedicated to promote the advocacy of the conversion and cultivation of suboptimal lands into productive lands, through the most environmentally, economically, and socially sustainable manner.