Macrothink Institute™

Journal of Agricultural Studies
ISSN 2166-0379
2020, Vol. 8, No. 3

The Assessment of Technology Millet (*Setaria Italica* (L) Beauv.) Based Multiple Cropping on Dry Land in Moluccas

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Received: Mar. 22, 2020 Accepted: Apr. 21, 2020 Published: May 6, 2020

doi:10.5296/jas.v8i3.16977 URL: https://doi.org/10.5296/jas.v8i3.16977

Abstract

Millet (*Setaria italica* (L) Beauv.) is classified as a cereal plant, potentially developed as an alternative food ingredient to support food self-sufficiency in the region and nationally. The study was carried in Waeperang, Lilialy Subdistrict, Buru Regency in 2017 with the aim of obtaining recommendation for technology package for millet-based double cropping that was able to increase productivity > 20%. The study was carried out with an adaptive approach, field trial approach, and dry land agroecosystem approach, using Randomized Block Design with four treatments and repeated five times (farmers as replications). Four treatments were tested, namely: (1) Technology of Existing Planting Pattern (Millet - Peanuts - Fallow), (2) Technology of Improved Farmer Planting Pattern (Millet + Corn - Peanuts - Fallow), (3) Technology of Introducing I Planting Pattern (Millet + Corn - Peanuts - Mungbeans) and (4) Technology of Introducing II Planting Pattern (Millet + Corn/Cassava - Peanuts - Mungbeans). The results of the study indicated that the multiple cropping pattern based on millet can increase productivity of millet compared to monoculture. Intercropping of millet, namely Introduction I Planting Pattern (C Pattern): Millet + Corn - Peanuts - Mungbeans and Introduction II Planting Pattern (D Pattern): Millet + Corn/Cassava - Peanuts - Mungbeans can increase the productivity of millet crops are 23.04% and 51.55%, respectively. Introduction D Pattern (Millet + Corn/Cassava - Peanuts - Mungbeans) can be recommended

as a double cropping pattern on dry land in Moluccas, and support dimensions of a food security, i.e access, availability, utilization and stability of food.

Keywords: millet, multiple cropping, dry land, productivity

1. Introduction

Rice is the main source of carbohydrates for most Indonesian people. The need for rice will increase with population growth. Meanwhile, rice production is difficult to increase, due to the limited area of irrigated harvests, reduced fertile land, global climate change and other production factors. The dependence of the Indonesian population on rice which is very high can cause food insecurity. Facing this problem, managing alternative foodstuffs is one of the strategic steps to prevent food insecurity, as well as providing food support to the food diversification program. Concept of food security at World Food Conference on 1974 in terms of food supply-assuring the availability and price stability of basic foodstuffs has changed which include food access, availability, food use and stability (FAO 2006). Worid Food Summit (1996), states that food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life. Declaration of the World Summit on Food Security to halt immediately the increase in – and to significantly reduce – the number of people suffering from hunger, malnutrition and food insecurity (World Summit on Food Security 2009).

Indonesia's diverse biological resources make it possible to obtain food resources other than rice, one of which is Millet. Serelia minor types of millet including C4 plants (Zooleh *et al*. 2011), is a potential commodity to be developed as a source of carbohydrates, potentially developed in sub optimal areas (drought) (Hidayati & Fauzia 2016). Millet (*Setaria italica* (L) Beauv.) is a type of cereal from the Poaceae family (Lata *et al*. 2012). The plants are planted and cultivated in a limited way on the Island of Buru (Moluccas) and the people of Buru Island use millet as an alternative food to rice, supporting efforts to diversify food and can also be used as functional food ingredients, to prevent degenerative diseases and sufferers of diabetes mellitus. More specifically, *Setaria italica* serves as a model in the process of domestication, photosynthesis of C4 plants, studies of tolerance to environmental stress, and the development of genomic sources (Hammer & Khoshbakht 2007; Li & Brutnell 2011; Hirano *et al*. 2011).

Millet cultivation does not require intensive maintenance like rice, so that it can be planted almost everywhere. Baker (2003) and Krishiworld (2005) said that hotpots can grow in tropical and subtropical climates on rainfed land to dry areas with dry climate, because these plants require relatively little water. Millet can also grow in the lowlands to the highlands (Suharno *et al.* 2015). Brink (2006); Baltensperger (2012) millet are annual crops and are easily cultivated on dry land, relatively short harvest age (less than 90 days), dry seed productivity of 800 - 900 kg/ha and 2.5 t/ha of straw. The advantages of millet cultivation are resistance to dry land, relatively high productivity, easy cultivation, can be used as food and feed, very adaptable to marginal land (Tirajoh *et al*. 2012). Even because of its high nutritional value, pokem until now has been widely used for various purposes (Prasetyo 2008; Tirajoh *et al*. 2014).

According to Malik (2012) *in* Suharno *et al*. (2015) this plant has several advantages, including being able to grow on dry land, crop production is quite high, easily cultivated, has a variety of uses, and has a high adaptability to marginal land and crop yields in panicle form, and after being dried can be stored for 20 years, can grow in all types of soil, withstood drought and harvest age is only 85 days, so that a year can be cultivated three (3) times the planting period. Another interesting thing about millet is its significant antioxidant content and low glycemic index and carbohydrate content of 81.32% (Herodian *et al*. 2007).

Potential land availability for the development of dry land agriculture (including millet) in Moluccas was recorded around 847,601 ha consisting of agroforestry (129,136 ha) with slope of 9% - 15% and lowland (718,465 ha) with slope of 3% - 8% (Susanto & Bustaman 2006), but only a small portion of 305,136.40 ha (36%) was used, so that the opportunity for extensification is still wide open at 542,464.64 ha or around 64% of potential land. According to Tirajoh *et al*. (2012), millet plants are resistant to dry land and highly adaptable to marginal land.

In an effort to increase land productivity and crop productivity on dry land the selection of multiple cropping patterns is a must (Yuwariah 2011; Randall *et al*. 2016). According to Beets (1982) and Bahar (1987), the advantage of applying intercropping or multiplecropping is to reduce the risk of crop failure, increase overall production, use labor more efficiently with scattered activities throughout the year, efficient use of land, water and sunlight as a natural resource, preservation of soil fertility can be maintained because of the presence of plants throughout the year, does not give a chance for weeds to grow, and improve the nutrition of farming families obtained from various plants.

The improvement of millet-based double farming pattern technology is expected to increase yield per unit area. Increased millet productivity has the opportunity to support sustainable food security at regional and national levels.

The aim of this study is to obtain a recommendation on the technology package for millet-based cropping patterns that can increase millet productivity > 20% compared to existing planting patterns.

2. Methodology

The Millet (*Setaria italica* L.) Double Planting Pattern Study on Dry Land in Moluccas Province was carried out with an adaptive research approach, a field experiment approach and a land agroecosystem approach in an effort to increase productivity (land and plants). This study was conducted in the village of Waeperang, District Lilialy, Buru Regency from February - December 2017.

The study used a randomized block design (RBD) with four treatments that were repeated five times (farmers as replications) and applied an adaptive research approach so that they met the rules of adaptive research (t-1) (n-1) > 11 (AARD 2005). The treatment plot area is 600 m^2 (20 m x 30 m), so the area of land needed for each cooperating farmer is 4 x 600 m2 = 2,400 m^2 or the total land requirement (5 farmers) is 5 x 2,400 m^2 = 12,000 m^2 (1.2 ha).

The four treatments include existing farmers' cropping pattern technology, improved farmers' cropping technology, and two alternative farmers' cropping technology. Determination of cropping patterns is adjusted to the distribution of rainfall (Figure 1).

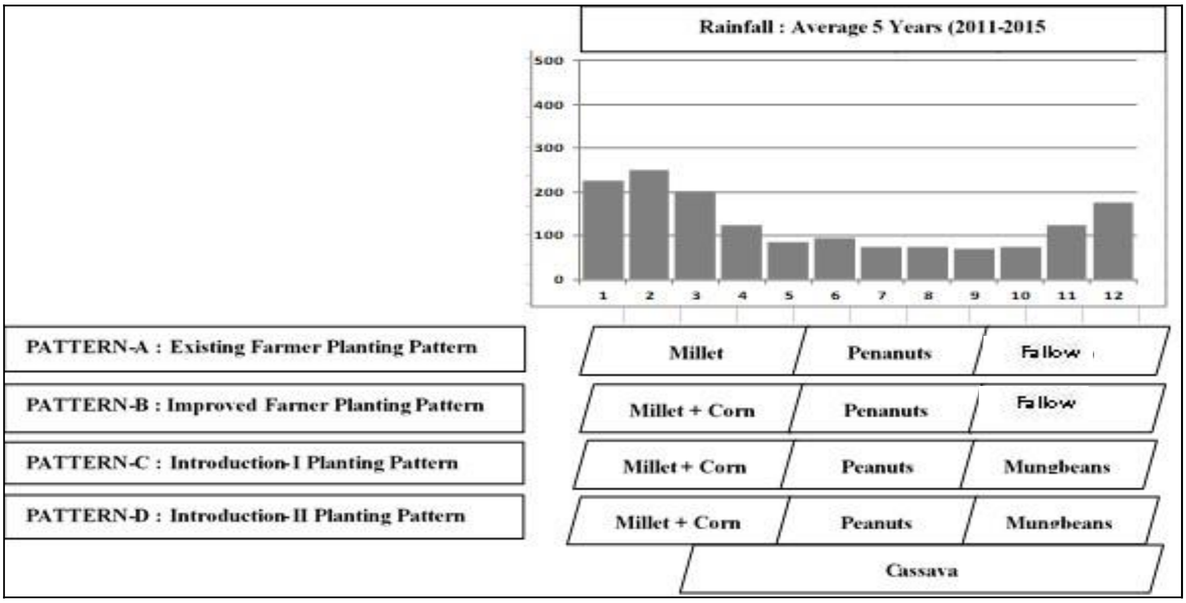

Figure 1. Millet-based Double Planting Pattern Technology Research Design According to Rainfall Distribution in Namlea District, Buru Regency (Data Source: Meteorology Station III Class of Namle-Buru in 2016)

The four millet-based double-cropping technology treatments are as follows:

(1) Pattern - A (Existing Farmer Planting Pattern)

Millet - Peanuts - Fallow

Millet is usually planted near the end of the rainy season (March) because it does not require high rainfall at the time of planting. In Pattern-A, millet is planted monoculture with a distance of 30 cm x 30 cm. To simplify the planting process, millet is mixed with 1: 5 sand (1 kg of millet mixed with 5 kg of sand). After the millet is harvested, the Local Red Peanuts variety are planted monoculture with a spacing of 20 cm x 20 cm. After the peanuts are harvested, the land is left empty and not planted (fallow). The dosage of fertilizing millet is 100 kg NPK Phonska/ha while the peanut is not fertilized. Pest control (plant-disturbing organisms) is not done either millet or peanuts. Pre-planting herbicide Roundup is given before tillage (4 L/ ha).

(2) Pattern - B (Farmer Improvement Planting Pattern)

Millet + Corn - Peanuts - Fallow

Pattern - B uses superior varieties of Yellow Srikandi corns and local Red varieties of peanuts and is grown in a straight forward manner. Improvements were made to farming methods, from monoculture to intercropping (millet + corn). In addition, improvements were made to the spacing of millet from the tile system (30 cm x 30 cm) to square (60 cm x 15 cm), improvement of the planting distance of maize from single lined spacing (60 cm x 40 cm) to 300 cm double row x (60 cm x 40 cm) and improvement of the distance of peanut plants from spacing of tiles (20 cm x 20 cm) to square (40 cm x 20 cm). After millet and corn are harvested, the land is planted with peanuts (monoculture), after harvesting peanuts, the land is left empty not planted (bero). Millet and corn plants are fertilized with the same dose of 90 kg N + 90 kg P_2O_5 + 45 kg K_2O per hectare is equivalent to 300 kg NPK phonska + 100 kg Urea / ha, while the dose of peanut fertilizer 45 kg N + 45 kg P_2O_5 + 15 kg K_2O is equivalent to 100 kg NPK Phonska + 67 kg Urea/ha. The main control of stem borer in corn plants is done by giving Furadan 3G through shoots at the age of 21 and 42 DAP (days after planting) at a dose of 30 kg/ha/application. Pest control on millet and peanuts is done by giving Baycarb insecticide (2 cc/L water) and carried out if there is an attack.

(3) Pattern - C (Alternative-I Cropping Pattern)

Millet + Corn - Peanuts - Mungbeans

Millet is intercropped with corn and the varieties used are also the same as Pola-B, only the land is not left fallow but planted with mungbeans. In Pattern-C, millet is planted using the legowo row 2: 1 planting system with 60 cm x (30 cm x 15 cm) spacing while Srikandi Kuning corn varieties are planted in double rows 300 cm x (60 cm x 40 cm). After millet and corn are harvested, peanuts are planted in a monoculture spacing of 40 cm x 20 cm. After the peanuts are harvested, the land is planted with mungbeans of superior variety Vima-1 and planted monoculture with a spacing of 40 cm x 20 cm. Doses of millet and corn fertilizer are the same as Pola-B, while peanuts and mungbeans are fertilized at a dose of 45 kg N + 45 kg P_2O_5 + 15 kg K_2O per hectare equivalent to 100 kg NPK Phonska/ha + 67 kg Urea/ ha. Pest control on millet, corn and peanuts is the same as in Pattern-B, while pest control of mung beans is carried out by monitoring (if there is an attack). Provision of Baycarb insecticide (2 cc/L water) in the vegetative phase and before the generative phase (starting to flower) until two weeks before harvest is given the Decis insecticide (0.5 cc/L water).

(4) Pattern - D (Alternative-II Planting Pattern)

Millet + Corn/Cassava - Peanuts - Mungbeans

Millet and corn are intercropped. Three weeks after planting corn, cassava is inserted. After millet and corn are harvested, the land is planted with peanuts and after the peanut is harvested the land is also planted with mungbeans. Millet, corn, peanuts and mungbeans use the same varieties as Pola-C and are grown in a straight forward manner. Millet is planted using the 4: 1 legowo planting system with a spacing of 60 cm x (30 cm x 15 cm), while corn plants are planted in double rows 300 cm x (60 cm x 40 cm). Three weeks before millet and corn are harvested, the Yellow Yellow variety of cassava is inserted into the corn row with a spacing of 60 cm x 80 cm. Other cultivation technology components (fertilizer dosage and pest control) for millet, corn, peanuts and mungbeans are the same as Pattern - C.

In accordance with the research objectives, namely the preparation of millet-based cropping pattern recommendations that can increase productivity> 20% compared to existing cropping patterns, the variables observed in the agronomic aspect are the components of plant growth and yield in 10 plant samples in each treatment cropping pattern.

Data analysis of the results of the research was carried out by the tabulation method and continued with descriptive analysis.

3. Results and Discussion

Growth and Yield of Millet Plants (Sequence of I Plants)

Millet plants are planted monoculture (Pattern-A: Millet – Peanuts - Fallow) and Intercropping (Pattern-B: Millet + Corn – Peanuts - Fallow), (Pattern-C: Millet + Corn - Peanuts - Mungbeans) and (Pattern-D: Millet + Corn/Cassava - Peanuts – Mungbeans). Table 1 shows that the millet plants grown in monoculture grow lower than if they are intercropped because millet and corn are C4 plants and are planted together so that the maximum growth of plants occurs simultaneously together, the maximum number of tillers is the same as the number of productive tillers, both in the monoculture cropping pattern (Pattern-A) and in the double cropping pattern (Pattern-B, Pattern-C, and Pattern-D). Millet plants will all grow and develop into productive tillers. Heat plants planted in intercropping give a higher number of productive tillers than if planted monoculture (Table 1). Likewise, other yield components (panicle length and panicle weight per clump) were higher in intercropping compared to monoculture. Furthermore, Table 1 shows that multiple farming patterns give panicle weights per clump and per sample plot higher than monoculture. This is due to the age of growth and harvest of plants that are intercropped differently, so as to reduce the level of competition between plants, conversely plants planted with monoculture patterns have uniform growth and harvest ages (Randall *et al.* 2016).

In Pattern B, the increase in panicle weight (per clump and per hectare) was not caused by an increase in population, but was due to the use of square spacing (60 cm x 15 cm) compared to the use of 30 cm x 30 cm tile spacing (Pattern-A). Square spacing is the distance between the rows of plants wider and the spacing in a narrow row of plants, this condition makes it easier to do so that the soil structure becomes loose.

Table 1. Average of Growth and Yield of Millet Plants in Various Farming Technologies Based on Millet, Buru, GS 2017

No.	Parameter of Millet	Patterns crops based on Millet			
		A	B	C	D
1	Plant height (cm)	102.2	106.0	107.0	114.7
2	Number of maximum thrust/clump	6.7	6.9	6.8	8.3
3	Number of productive thrust/clump	6.7	6.9	6.8	8.3
4	Length of panicle (cm)	26.3	26.5	26.7	28.6
5	Weight of panicle/clump (g)	3.4	2.6	4.1	6.6
6	Weight of panicle/sample plot (g/22.68 m^2)	1,540.0	1,654.2	1,894.8	2,333.8
7	Weight of panicle/ha (t)	0.68	0.73	0.83	1.03
8	Dry grain yield of millet/ha (t)	0.373	0.401	0.459	0.565
9	Population of millet/ha (%)	100.0	90.0	120.0	140.0
10	Increase productivity millet to eksisting farmer pattern (%)	-	7.42	23.04	51.55

Remarks:

*) Sample plot size 4.2 m x 5.4 m

**) Millet dried seed yield = 55% x panicle weight

Pattern - A (Existing Farmer Planting Pattern): Millet - Peanuts - Fallow

Pattern - B (Improved Farmer Planting Pattern): Millet + Corn - Peanuts - Fallow

Pattern - C (Introduction I Planting Pattern): Millet + Corn - Peanuts - Mungbeans

Pattern - D (Introduction II Planting Pattern): Millet + Corn/Cassava - Peanuts - Mungbeans

Loose soil creates good aeration for root breathing, so the displacement process does not go smoothly, resulting in increased yield. This is in accordance with Rachman *et al*. (2004); Khairunnisa *et al*. (2015) is a condition of soil looseness in regulating better soil structure and aeration for root growth. According to Istiqomah *et al*. (2016), good structure and aeration will provide easier and more flexible root space to make the root's ability to not bind, air and oxygen become larger and the process of photosynthesis can run quickly.

Table 1 shows the highest yields of dried millet seeds per hectare (0.565 t / ha) achieved in Pattern-D, then Pattern-C (0.459 t/ha) and Pattern B (0.401 t/ha). While the lowest yield of dried millet seeds (0.373 t/ha) was achieved in the monoculture cropping pattern (Pattern-A). Thus there is an increase in the millet provitas in the double cropping pattern (Pattern-B, Pattern-C, and Pattern-D), combined by 7.42%, 23.04% and 51.55%,) compared to monoculture planting patterns (Patterns-A = Existing Farmer Planting Pattern), as presented in Table 1.

Growth and Yield of Corn (Sequence of II Plants)

Variable growth components, yield components and corn yields collected were plant height, cob height, cob length and diameter, weight of 100 grains, and dry weight of seeds per plant, as presented in Table 2. Table 2, shows the average plant height and cob height approved in this review was completed, followed by 175.30 cm and 62.06 cm. D-Planting (Millet + Corn/Cassava - Peanuts - Mungbeans) grows more than the Cropping Pattern-C (Millet + Corn - Peanuts - Mungbeans) and handle Pattern-B (Millet + Corn - Peanuts). This provides more yield components (cob length and diameter, weight of 100 seeds, and dry weight of seeds per plant). High yield component will give high dry grain yield and vice versa. cropping Pattern-D gives lower dry shell yield compared to planting Pattern-B and Pattern-C, this is related to competition between cassava plants which are planted/inserted by corn plants.

Table 2. Average of Growth and Yields of Corn in Various Millet-Based Farming Technologies, Buru, GT. 2017

No.	Parameter of Corn	Patterns crops based on Millet			Average
		B	C	D	
1	Plant height (cm)	174.81	174.55	176.53	175.30
2	The height of the cobs (cm)	61.35	61.87	62.95	62.06
3	Cob Length (cm)	11.35	11.12	11.09	11.19
4	Cob Diameter (cm)	3.81	3.82	3.80	3.81
5	Weigth of 100 grain (g)	26.73	26.82	26.13	26.56
6	Dry seeds weight/plants (g)	113.46	118.34	112.49	114.76
7	Dry seeds weight/sample plot (g/22.68 m^2) *)	4247.94	4430.65	4211.63	4247.94
8	Dry shelled yields/ha (kg)	1.873	1.954	1.857	1.895
9	Corn Population (%)	36	36	36	-

Remarks:

*) Sample plot size 4.2 m x 5.4 m

Pattern - B (Improved Farmer Planting Pattern): Millet + Corn - Peanuts - Fallow

Pattern - C (Introduction I Planting Pattern): Millet + Corn - Peanuts - Mungbeans

Pattern - D (Introduction II Planting Pattern): Millet + Corn/Cassava - Peanuts – Mungbeans

Competition occurs with growth factors such as nutrients, water, sunlight and space, although it does not have a real effect. Plant spacing affects the amount of light intensity and the availability of nutrients needed for plants. The wider the planting distance, the greater the intensity of light and the more nutrient availability for individual plants, because the number of trees is less (Mawazin & Hendi 2008).

The yield of dry shelled corn seeds per hectare achieved in this study was 1.895 t/ha. The highest yield of dry shelled corn per hectare (1,954 t/ha) was achieved in the plantingof Pattern-C (Millet + Corn - Peanuts - Mungeans), following the treatment of Planting-B Pattern (Millet + Corn - Peanut), 1,873 t/ ha and treatment of Planting Pattern-D (Millet + Corn/Cassava - Peanuts - Mungbeans), 1,857 t/ha.

Growth and Yield of Peanut

Peanuts are second order after monoculture millet (Pattern-A) is harvested and planted with spacing of tiles (30 cm x 30 cm), according to the spacing of existing farmers. Whereas second order peanuts (after millet and corn are harvested), are planted with a square spacing (40 cm x 20 cm). Peanuts in Pattern-A, Pattern-B, and Pattern-C are sequence II plants (after millet and maize are harvested) monocultured (100% population). Whereas in Pattern-D, peanuts with a population of 75% are intercropping after millet and maize harvest and intercropping with cassava.

Peanut variables observed included plant height, pod length, number of pods contained per plant, percentage of young pods per plant, weight of 100 grains, weight of pods contained per plant and per sample plot and yields of dried pods per hectare are presented in Table 3.

Table 3 shows that the peanuts planted in conching (Pattern-D) give a higher plant height than if planted monoculture, but conversely the yield components (pod length, number and weight of pods contained per plant, and weight of 100 grains) tend to decrease (Table 3). This is due to the influence of the shade of cassava insertion plants. Taiz & Zeiger (1991) report that shaded leaves absorb little in infra red, causing changes in phytochrome and plant characteristics to be higher.

Bakhshy *et al*. (2013) reported that shade caused the height of the stems of soybean plants. The low light intensity during plant development, will cause symptoms of etiolation by the activity of the auxin hormone. The canopy part of the plant which is exposed to light will slow growth because the work of auxin is inhibited by light, while in the canopy of plants that are not exposed to light, its growth is very fast because the work of auxin is not inhibited. This condition makes the canopy (apical) of plants experience the most active growth so that plants grow looking for light to carry out more optimal photosynthesis (Handriawan *et al*. 2016).

Table 3. Average of Growth and Yields of Peanuts in Various Millet-Based Farming Technologies, Buru, GT. 2017

No.	Parameter of Peanuts	Patterns crops based on Millet			
		A	B	C	D
1	Plant height (cm)	56.72	57.24	58.35	65.75
2	Length of pods (cm)	4.13	4.26	4.25	4.05
3	Number of filled pods/plants	45.60	49.00	48.75	42.03
4	Percentage of young pods/plants (%)	14.93	9.33	8.56	15.25
5	Weigth of 100 grain (g)	53.05	53.25	53.15	52.58
6	Weigth of filled pods/plants (g)	96.55	99.50	98.40	92.45
7	Weigth of filled pods/sample plot (g/22,68 m^2)	2,592.38	2,725.85	2,644.90	1,822.19
8	Yield of dry pods/ha (kg)	1.143	1.202	1.166	0.803
9	Yield of dry grain/ha (kg)	0.743	0.781	0.758	0.522
10	Population of Peanuts/ha (%)	100.00	100.00	100.00	75.00

Remarks:

*) Sample plot size 4.2 m x 5.4 m

**) Dry seed yield = 65% x dry pod weight

Pattern - A (Existing Farmer Planting Pattern): Millet - Peanuts - Fallow

Pattern - B (Improved Farmer Planting Pattern): Millet + Corn - Peanuts - Fallow

Pattern - C (Introduction I Planting Pattern): Millet + Corn - Peanuts - Mungbeans

Pattern - D (Introduction II Planting Pattern): Millet + Corn/Cassava - Peanuts - Mungbeans

As a result of the low yield components in intercropping/cassava with peanuts affect the results achieved. Table 3 shows that Pattern-D (Overlap of Peanut) yields dry beans per hectare tends to be lower than if peanuts are planted monoculture. The highest dry seed yield (0.781 t/ha) was achieved in the Pattern-B, following the Pattern-C (0.758 t/ha) and Pattern-A (0.743 t/ha).

Growth and Yield of Mungbeans

Mungbeans are sequence III plants which are planted monoculture after monoculture peanuts (Pattern-C) with a spacing of 40 cm x 20 cm (population 100%). Whereas mungbean in Pattern-D is also a third order crop, planted in cone-shaped, although using the same spacing as Pattern-C, the plant population is 75% (Pattern-D), because cassava plants have not been harvested.

The observed variables of mung bean plant included plant height, pod length, number of bees per plant, percentage of empty pods per plant, weight of pithy seeds per plant, weight of 100 grains, weight of pithy seeds per sample plot and yield of dried seeds per hectare, as presented in Table 4.

Table 4. Average of Growth and Yields of Mungbeans in Various Millet-Based Farming Technologies, Buru, GT. 2017

No.	Parameter of Mungbeans	Patterns crops based on Millet	
		C	D
1	Plant height (cm)	51.34	61
2	Length of pods (cm)	10.45	10.32
3	Number of filled pods/plants	44.94	41.44
4	Percentage of hollow (empty) pods/plant (%)	4.83	8.03
5	Weigth of 100 grain (g)	6.35	6.15
6	Weigth of filled pods/plants (g)	15.62	13.80
7	Weigth of filled pods/sample plot (g/22,68 m^2)	3390.64	3337.39
8	Yield of dry grain/ha (kg)	1.495	1.104
9	Population of Mungbeans/ha (%)	100	75

Remarks:

*) Sample plot size 4.2 m x 5.4 m

**) Dry seed yield og Mungbeans = 65% x dry pod weight

Pattern - C (Introduction I Planting Pattern): Millet + Corn - Peanuts - Mungbeans

Pattern - D (Introduction II Planting Pattern): Millet+Corn/Cassava-Peanuts-Mungbeans

Table 4 shows that mungbeans as a secondary crop II (after intercropping millet + corn), intercropping/overlap cropping (Pattern-D) gives plant height and the percentage of empty per plant tends to be higher than if planting intercropping (Pattern-C). On the other hand, mungbean planted in intercropping/overlap cropping (Pattern-D) gives yield components (pod length, number of pods contained per plant, and weight of 100 grains and pithy seeds per plant) mung beans tend to be lower. This is because in Pattern-D there are still cassava plants that affect the growth of mung bean plants due to the influence of shade. According to Taiz & Zeiger (1991) plants in the shade treatment undergo etiolation process so that plant growth is higher, as well as leaf area, where in young plants an increase in leaf area increases in shade level.

Besides the low component of mungbean yield in the D-Pattern followed by a low population (75%) causes the results achieved are also low. The results of third order mung beans achieved in Pattern-D (1,104 t/ha) tend to be lower when compared to third order mung beans which are planted monoculture (Pattern-C), which is 1,495 t/ha.

Growth and Yield of Cassava Plants

Cassava is a sequence II plant as an insert crop in the intercropping pattern of millet + corn, namely Pattern-D (Introduction II Planting Pattern: Millet + Corn/Cassava - Mungbean). Local varieties of cassava (8 months) are planted and inserted in maize rows, three weeks before the harvest of millet and corn with a spacing of 300 cm x (60 cm x 80 cm), population 36%. The cassava variables observed included plant height, length of tubers for sale, tuber diameter, percentage of small tubers, fresh tuber weight per plant and per sample plot and yield of fresh tubers per hectare, as presented in Table 5.

Table 5. Average Growth and Yields of Cassava on Various Farming Technologies Based on Millet, Buru, MT 2017

No.	Parameter of Cassava	Patterns crops based on Millet
		D
1	Plant height (cm)	257.50
2	Length of tuber for sale (cm)	41.00
3	Diameter of tuber (cm)	8.10
4	Number of tuber for sale/plant	20.20
5	Persentage of small tuber (%)	27.72
6	Weigth of fresh tuber/plant (g)	1371.67
7	Weigth of fresh tuber/sample plots (g/22.68 m^2) *)	64811.41
8	Yield of fresh tuber/ha (t) **)	10.288
9	Population cassava (%)	36.00

Remarks:

*) Sample plot size 4.2 m x 5.4 m

**) Fresh tuber yield/ha (based on population)

Pattern - D (Introduction II Planting Pattern): Millet+Corn/Cassava-Peanuts-Mungbeans

The height of cassava plant reached was 257.50 cm (Table 5). The D-Pattern treatment gives the length and diameter of the tubers for sale which are achieved respectively 41.00 cm and 8.10 cm, the number of tubers sold per plant (20.20 tubers), the percentage of small tubers 27.72%, the weight of fresh tubers per plant (1,371.67 g), and fresh tuber weights per plot (2.7433.33 g/22.68 m^2). And the yield of fresh tubers per hectare achieved in the Pattern-D (Millet + Corn/Cassava-Mungbeans) of 10,288 t / ha.

4. Conclusion

Intercropping of millet plants using by jarwo 2: 1 and jarwo 4: 1 spacing can increase population and productivity of millet compared to monocultur system.

Intercropping of millet, namely Introduction I Planting Pattern (C Pattern): Millet + Corn - Peanuts - Mungbeans and Introduction II Planting Pattern (D Pattern): Millet + Corn/Cassava - Peanuts - Mungbeans can increase the productivity of millet crops are 23.04% and 51.55%, respectively.

Introduction D Pattern (Millet + Corn/Cassava - Peanuts - Mungbeans) can be recommended as a double cropping pattern on dry land in Moluccas, and support dimensions of a food security, i.e food availability, food access, utilization and stability of food.

Acknowledgments

We express our high thanks and appreciation to Dr. Ir. Janes Berthy Alfons, M.Si whom have provided guidance in field research so that this activity is carried out well. We also thank all parties that we cannot mention one by one for all their assistance during this activity.

References

[AARD] Agency of Agricultural Research and Development. 2005. Guidelines for Assessment and Dissemination of Study Results. Agricultural Research and Development Agency. Agriculture Department.

Bahar, F. (1987). Technical Training Paper on the Nusa Tenggara Agricultural Research and Development Project. Agricultural Research and Development Agency.

Baker, R. D. (2003). Millet Production. Cooperative Extension Service. College of Agriculture and Home Economics of New Mexico State University. The USA.

Bakhsky, J., Ghassemi-Golezani, K., Zeltab-Salmasi, S., & Moghaddam, M. (2013). Effects of Water Deficit and Shading on Morphology and Grain Yield of Soybean (*Glicine max*. L). *TJEAS Journal, 3,* 39-43. https://doi.org/10.12692/ijb/3.2.71-79

Baltensperger, D. D. (2012). Foxtail and Proso Millet. http://www.hort.purdue.edu/newcrop/proceedings1996/v3-182.html (January 28, 2012).

Beets, W. C. (1982). Multiple Cropping and Tropical Farming System. Colorado: Westview.

Brink, M. (2006). *Setaria italica* (L.) P. Beauv. Record from Protabase. Brink, M. and Belay, G. (Eds.). PROTA (Plant Resources of Tropical Africa/Ressources Végétales de l'Afrique Tropicale), Wageningen, Netherlands (January 25, 2010).

FAO. (2006). *Food Security*. Policy Brief. Issue 2. June 2006. https://doi.org/10.1016/S1353-4858(06)70332-4

Hammer, K., & Khoshbakht, K. (2007). Fox milltail (*Setaria italica* (L.) P. Beauv.) In Mazandaran/ Northern Iran. *Genet Resour Crop Evol.*, *54*(4). https://doi.org/10.1007/s10722-007-9211-z

Handriawan, A., Respati, D. W., & Tohari. (2016). The Effect of Shade Intensity on Growth and Yield of Three Soybean Cultivars (*Glycine max* (L) Merrill) in the Sand Land of Bugel Kulon Progo Beach. *J. Vegetalika*, *5*(3), 1-14.

Herodian, S., Sugiyono, Sri Widowati, S., & Susila, B. A. (2007). Development of Millet Hunt (*Setaria italica* (L) Beauv) as an Alternative Staple Food Source.

Hidayati, N., & Fauzia, S. (2016). Evaluation of Five Accessions of Local Jewels [Setaria italica (L) P. Beauv.)]: Character opposes and Responses to Fertilization. Proceedings of Sem A Bio., 232.

Hirano, R., Naito, K., Fukunaga, K., Watanabe, K. N., Ohsawa, R., & Kawase, M. (2011). Genetic Structure of Landraces in Milltail Tails (Setaria italica (L.) P. Beauv.) Revealed with Display Transposon and Interpretation to Crop Evolution of Foxtail Millet. *Genome*, *54*(6), 498-506. https://doi.org/10.1139/g11-015

Istiqomah, N., & Mahdiannoor, R. F. (2016). Soil Processing Methods Against Alabio Cassava (*Dioscorea alata* L.). *Ziraaah*, *41*(2), 233-236.

Khairunnisa, L. R. R., & Irmansyah, T. (2015). Growth Response and Production of Sorghum (*Sorghum bicolor* (L.) Moench) by Giving Mulch and Soil Tillage Methods. *Agroecotechnology Online Journal*, *3*(1), 359-366. Dec. 2015.

Krishiworld. (2005). Filtering Setaria italica (L.) Beauv. http://www.krishworld.com/strartsearch.asp. *In*. Prakoso, Wahyu T. 2006. Planting Study Methods in Millet Buru Cultivation. Thesis. Faculty of Agricultural Technology. Bogor Agricultural Institute. Bogor. [Accessed, 25 February 2012]

Lata, C., Sarika, G., & Manoj, P. (2012). Millet Fox: A Model Plant for Genetic and Genomic Studies in Bioenergy Grass. Critical Review in Biotechnology, 2012; Early online: 1-16

Li, P., & Brutnell, T. P. (2011). *Setaria viridis* and *Setaria italica*, Genetic System Models for Panicoid Grass. *Journal of Experimental Botany*, *62*(9), 3013-3037. https://doi.org/10.1093/jxb/err096

Mawazin, H. S. (2008). Effect of Spacing on Changing Dyer *Shorea parvifolia* Diameter. *Forest Research and Nature Conservation*, *5*, 381-388. https://doi.org/10.20886/jphka.2008.5.4.381-388

Prasetyo, R. (2008). Evaluation of Nutrition Quality and Glycemic Index of Processed Millet

Products (Setaria italica). Thesis. IPB. Bogor.

Rachman, A., Ai, A., & Husen, E. (2004). Soil Conservation Technology on Sloping Dry Land. Center for Land and Agro-climate Research and Development. *Bogor. Thing*, 183-204

Randall, A., Yuwariah, Y., Nuraini, A., Nurmala, T., Irwan, A. W., &Qosim, W. A. (2016). Characterization and Kinship 23 Genotype of Millet (*Setaria italica* (L) Beauv.) Planted with Intercropping with Sweet Potatoes Based on Agromorphological Characteristics. *Journal of Food*, *25*(1), 21-32

Suharno, S. S., Agustini, V., & Tanjung, R. H. R. (2015). The Effort of Domestication of Pokem {Setaria italica (L.) Beauv} by Local Communities at Numfor Island, Biak Numfor Regency in Supporting National Food Security. *J. People and Environment*, *22*(1), 73-83, Maret 2015. https://doi.org/10.22146/jml.18727

Susanto, A. N., & Bustaman, S. (2006). Land Resources data and information for Agribusiness development in the Moluccas Islands Region. Ambon: Moluccas Assessment Institute Agricultural Technology, IAARD. 73 pp.

Taiz, L., & Zeiger, E. (1991). Plant Physiology. Tokyo. The Benjamin/Cumming Publishing Company Inc., 219-247.

Tirajoh, S, Achmanu, S. O., & Widodo, E. (2012). Nutrient Composition of Two Different Fox Millet Varieties (*Setaria italica* sp.) and their Potential Use as Animal Feed Ingredients. *International Conference on Animal Production and Veterinary Technology*, 104-108.

Tirajoh, S., Achmanu, S. O., & Widodo, E. (2014). Evaluation of Nutrition Values of Papuan Fox Fur Millet (*Setaria italica* sp) and its Replacement Effects on Yellow Corn in Broiler Show. *International Journal of Agronomy and Agricultural Research*, *4*(5), 195-201.

World Food Summit. (1996). *Rome Declaration on World Food Security.* Rome Italy, 13-17 November 1996.

World Summit on Food Security. (2009). *Declaration of the World Summit on Food Security*. Rome, 16-18 November 2009.

Yuwariah, Y. (2011). Sustainable Agriculture System. Faculty of Agriculture, Padjadjaran University, Jatinangor, Bandung.

Zooleh, H. H., Jahansooz, M. R., Yunusa, I., Hosseini, S. M. B., Chaichi, M. R., & Jafari, A. A. (2011). Effect of Alternative Irrigation on Foxtail Root-Devided Millet (*Setaria italica* (L) Beauv.). *Australian Journal of Crop Science*, *5*(2), 205-2013.

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