Food crops farming under Sunan candlenut (*Reutealis trisperma* (Blanco) Airy Shaw) stand at Pati and Asembagus

B Santoso¹, M Cholid¹ and Soemarno²

¹Indonesian Sweeteners and Fiber Crops Research Institute ¹Karangploso Street Post Box 199 Malang
²Faculty of Agriculture of Brawijaya University Veteran Post Box 165145 Malang

*Email: b_santoso111@yahoo.com*

**Abstract.** The main obstacle in developing Sunan candlenut plants is slow productive age (fruiting in the 5-6th year). By integrating food crops as intercrops between candlenut plants, farmers are expected to still be able to obtain income from intercropping before the candlenut plants produce. In addition, intercropping can optimize nutrient utilization from soil and fertilization, and increase soil fertility by using intercrop residual biomass. The selection of intercropping plants was adjusted to the interests of farmers by utilizing the space between the stands of candlenut trees. In the selection of food crops must be considered factors of climate suitability, altitude, soil type, cultivated soil layer thickness, and rain characteristics. This research was aimed to evaluate the farming income of intercropping candlenut with mung beans, sesame, peanut and maize. The results of farm analysis of each intercropping plant, namely: mung beans, sesame, peanut and maize each of them gave a profit per hectare of 11,380,000 IDR, 4,510,000 IDR, 24,375,000 IDR, and 6,080,000 IDR respectively.

1. **Introduction**

Kemiri Sunan (candlenut) is perennials plant producing biodiesel, this plant begins to flower after the age of 5-6 years [1][2][3][4][5]. Candlenut plantation condition (up to the age of 5-6 years) allows the planting of intercropped plants such as corn, peanuts, mung beans and sesame to increase farming income. Besides that, the presence of intercrop plant in a candlenut plantation with wide spacing (7 m x 7 m) can suppress weed growth [6]. Perennials are usually planted with wide spacing so that the distance between rows can be planted with an annual plant type as intercropping until perennials are 5-6 years old [7][8][9][10].

This intercropping pattern has a requirement, namely, intercropping has a different habitus than the main plant, in terms of root structure, CO2, air (O2), water (soil moisture), and nutrient requirements [10][11][12]. The types of corn, peanuts, mung beans, and sesame have a C3 carbon trajectory, while the candlenut carbon trajectory is C4 [13]. The intercropping pattern of candlenut with food crops can increase soil fertility [14]. The most ideal integration is perennial plants (such as candlenut) with intercropping plants (such as peanuts, mung beans), these intercropping plants can fix N2 in the air. Legumes are also good at releasing fixed P-soil [15].

Intercropping of annual crops (upland rice plants, secondary crops, rhizome plants) with perennials such as candlenut, coconut, and rubber, proved to be very beneficial in ecology and economics [16].
When sunan candlenut plants have not been fruitful, it is necessary to use the growing space between the rows of plants, so that land use is more efficient (Sastrosupadi et al., 2019 [13]).

The intercropping pattern is one of the ways to plant multiple crops in a plot of land, within one year to increase production and income [17]. Some advantages of intercropping system are that the surface of land is not open, covered by plant canopies so that evaporation can be reduced [18][19], reducing rainwater erosion and runoff [20][21] and can better guarantee crop yields [22]. Intercropping patterns also have the effect of reducing disturbances caused by pests, diseases and weeds [23][24][25][26][27].

The study aimed to determine farming income on intercrops (corn, peanuts, mung beans, sesame) in the candlenut plantation on Alfisols and Entisols

2. Material and methods

This research was conducted at Pati Research Station, Asembagus Research Station, and in 2017. Which located at 80° 12’ 4,66” South Latitude and 1120° 27’ 37” East Longitude (BT); 70° 45’ 18,39” South Latitude (LS) and 1140° 15’ 7,63” East Longitude (BT); and 60° 44’ 56,80” South Latitude (LS) and 1110° 0,2’ 0,6,96” East Longitude (BT), respectively.

The soil characteristics of the study site were rain and dry soil. Agro-climatic conditions at the study site belong to the C3 climate classification, with a short rainy day, only around 4-5 months. The secondary crops include peanuts, corn, mung beans, and sesame seeds. By using plant spacing; for corn plants 80 cm x 30 cm, for peanuts 20 cm x 20 cm, for mung beans 60 cm x 20 cm and for sesame 50 cm x 20 cm. Varieties of secondary crops used are peanuts Grd Biga, Pioneer hybrid maize, mung beans Betet and Sesame Sbr 2 or Winas 1. Land preparing was carried out using cow plows. Planting commodities were done manually by making a planting hole using tugal. The planted seeds per planting hole were 1 seed for corn, 2 seeds for peanut 2-3 seeds for mung bean 4-5 seeds for sesame. The plot size was 6 m x 6 m.

Inorganic fertilizer dosage for sesame: (100 kg N + 120 kg P₂O₅ + 100 kg K₂O)/ha.
Inorganic fertilizer dosage in mung beans: (20 kg N + 60 kg P₂O₅ + 50 kg K₂O)/ha.
Inorganic fertilizer dosage in peanuts: (60 kg N + 100 kg P₂O₅ + 100 kg K₂O)/ha.
Fertilizer dose in corn: 120 kg N /ha.

The provision of fertilizer is by making a hole near the plant, then covered with husk ash. Secondary crop cultivars consisted of hybrid corn, betet mung beans, GR Biga peanut, and Sbr2 sesame. Embedding is done twice at 5 and 10 days after planting, using seeds assigned. When the secondary crops grow, the pests that appear were *Empoasca* sp. or leaf fluid sucking pests, controlled using monocrotophos 0.3-0.6 g/l. Fusarium and leaf rot were sprayed with karbendazim 0.19 g/l and mankomez 2.21 g/l. Soil insect pests were controlled by using seeds with Cabufuran 3G 5 grams per plant. Weeding was done manually by human labor using a small sickle. Irrigation is given 3 times during fertilization, growth, and filling of seeds. Harvesting of corn, at age 120 days, mung bean, 70 days, sesame, 120 days, and peanuts, 100 days. The parameters observed included the weight of dried corn shell, peanut seeds, mung bean seeds, sesame seeds and farming analysis from each commodity. Besides that, the value of the B/C ratio and farm profits were also calculated and soil chemical analysis in the two study locations was analyzed.

3. Results and discussion

The results of the research of each intercropping with Sunan candlenut in Pati, Central Java, and Asembagus, Situbondo, East Java are presented in Tables 1, 2, 3 and 4.
Table 1. Monoculture farming (per ha) of peanut as intercrop in the Sunan candlenut plantation in Pati-Regency.

| No | Physical unit, per ha | Price per unit IDR/ha | Financial Value IDR/ha |
|----|----------------------|----------------------|-----------------------|
| I  | Production of peanut pods, kg | 2.469 | 15.000 | 37,035,000,- |
| II | Production cost of peanut monoculture farming: | | | |
| 1. | Soil tillage, ha | 1 | ...... | 800,000,- |
| 2. | Anorganic fertilizer N,P₂O₅, and K₂O, kg | 100 | ...... | 230,000,- |
| 3. | Superphosphate fertilizer, kg | 150 | ...... | 360,000,- |
| 4. | Peanut seeds, kg | 75 | ...... | 3,000,000,- |
| 5. | Decis EC insecticide, litre | 30 | ...... | 720,000,- |
| 6. | Peanut seeds planting, WD | 40 | ...... | 1,400,000,- |
| 7. | Peanuts replanting, WD | 5 | ...... | 175,000,- |
| 8. | Fertilizer application, WD | 30 | ...... | 1,350,000,- |
| 9. | Pest control, WD | 30 | ...... | 1,050,000,- |
| 10. | Harvest, WD | 40 | ...... | 1,400,000,- |
| 11. | Seed separation and drying | 10 WD | ...... | 450,000,- |
| 12. | Peanut monoculture production total cost | | | 12,660,000,- |
| 13. | Income = I - II | | | 24,375,000,- |

Note: The price of peanut seeds is 40,000 IDR/kg; NPK compound fertilizer 2300 IDR/kg; SP-36 fertilizer 2400 IDR/kg; Decis EC insecticide 500,000 IDR/liter; peanut consumption 15,000 IDR/kg; male labor wages 45,000 IDR/day; and female labor wages of 35,000 IDR/day; WD = working day.

Table 2. Corn monoculture farming (per ha) as intercrops in the Sunan candlenut plantation in Pati Regency.

| No | Physical unit Per ha | Financial Value (IDR/ha) |
|----|----------------------|-------------------------|
| I  | Corn Production (dry grain), kg | 4,500 | 13,500,000,- |
| II | Production cost of monoculture corn farming: | | |
| 1. | Soil tillage, ha | 1 | 2,250,000,- |
| 2. | Urea, kg | 300 | 630,000,- |
| 3. | Seeds of corn, kg | 25 | 500,000,- |
| 4. | Seeds planting, WD | 12 | 600,000,- |
| 5. | Reseeding of corn, WD | 4 | 200,000,- |
| 6. | Fertilizer application, WD | 10 | 500,000,- |
| 7. | Weed control, WD | 25 | 1,250,000,- |
| 8. | Harvest, WD | 17 | 850,000,- |
| 9. | Postharvest handlings, WD | 10 | 500,000,- |
| 10. | Mankonzeb insecticide (154 WSc). Litre | 2 | 150,000,- |
| | Total of production cost | | 7,430,000,- |
| | Farming Return I-II | | 6,080,000,- |

Notes: The price of corn seeds is 20,000 IDR/kg; urea fertilizer 2,100 IDR/kg; corn prices for consumption 3,000 IDR/kg; male labor wages 50,000 IDR/day; female labor wages 50,000 IDR/day; WD = working day.

Table 1 shows that peanut production is 2,469 kg/ha with market price at that time 15,000 IDR/kg, the total revenue is 2,469 x 15,000 = 37,035,000 IDR/ha. Costs incurred for secondary crop farming are 12,660,000 IDR/ha. Net income 37,035,000 IDR - 12,660,000 IDR = 24,375,000 IDR/ha. B/C ratio = 24,375,000: 12,660,000 = 1.93. The value of B/C ratio = 1.93 (B/C > 1.0), means that peanut intercropping in Sunan candlenut plantation is very profitable. The production of peanut intercropping...
in Muktiharjo Sunan candlenut plantation is high, the type of peanuts planted is new superior cultivars with high production, resistant to pests and early maturity only around 100 days.

Table 2 shows that corn production was 4,500 kg/ha with market price at that time 3,000 IDR/kg, the total revenue is 4,500 x 3,000 IDR/kg = 13,500,000,- IDR Net income = 13,500,000 IDR - 7,430,000 IDR= 6,080,000 IDR/ha. B/C ratio = 13,500,000 IDR : 6,080,000 IDR = 2.22. The value of B/C ratio >1 means that integrated farming between corn + candlenut is very profitable.

The type of corn used was Pionier 5 hybrid variety, which has a high production level. In general, hybrids have perpendicular leaf shapes that are very efficient in receiving sunlight penetration. This is related to the producing sinks (carbohydrates) photosynthetic process which is used for plant growth.

Table 3 showed that sesame production was 1,500 kg/ha with market price at that time 10,400, IDR/kg, the total revenue was 1,500 x 10,400, IDR/kg = 15,600,000, IDR Net income = 15,600,000 IDR - 11,090,000 IDR= 4,510,000 IDR/ha. B/C ratio = 4,510,000 IDR : 11,090,000 IDR = 0.40 Value of B/C ratio <1 means that integrated farming between sesame + candlenut is very unfavorable.

Table 3. Sesame monoculture farming (per ha) as intercrops in the candlenut plantation, Asembagus.

| No | Physical unit, per ha | Financial value, IDR/ha |
|----|----------------------|------------------------|
| I. | Production of sesame seeds, kg | 1,500 | 15,600,000,- |
| II. | Production cost of sesame monoculture: | | |
| 1. | Soil tillage, ha | 1 | 800,000,- |
| 2. | NPK compound fertilizer, kg | 150 | 420,000,- |
| 3. | Urea fertilizer, kg | 100 | 220,000,- |
| 4. | Sesame seeds, kg | 4 | 100,000,- |
| 5. | Sesame seed planting, WD | 45 | 2,250,000,- |
| 6. | Reseeding sesame, WD | 2 | 100,000,- |
| 7. | Weed control I, WD | 30 | 1,500,000,- |
| 8. | Weed control II, WD | 30 | 1,500,000,- |
| 9. | Thinning sesame plant, WD | 30 | 1,500,000,- |
| 10. | Fertilizer application, WD | 15 | 750,000,- |
| 11. | Sesame irrigation, times | 2 | 200,000,- |
| 12. | Sesame Harvest, WD | 45 | 2,250,000,- |
| 13. | Sesame grain handlings, WD | 15 | 750,000,- |
| 14. | Monocrotofos 200 MX, package | 1 | 250.00 |

Total II 11,090,000,-

Income I-II 4,510,000,-

Notes: The price of sesame seeds was 25,000 IDR/kg; NPK compound fertilizer 2,800 IDR/kg; Urea 2,200 IDR/kg; the price of sesame for consumption was 10,400 IDR/kg; male labor wages 50,000 IDR/day; female labor wages 45,000 IDR/day; irrigation 100,000 IDR once irrigates; WD = working day.

Table 4 shows that mung beans production was 1,400 kg/ha with market price at that time 12,500 IDR/kg, total revenue was 1,400 x 12,500 IDR/kg = 17,500,000 IDR. Net income = 17,500,000 IDR - 4,300,000 IDR = 13,200,000 IDR/ha. B/C ratio = 13,200,000 IDR : 4,300,000 IDR= 3.07. The B/C ratio of 3.07 (B/C > 1.0) means that integrated farming of mung beans in Sunan candlenut plantation is very profitable. Green bean cultivars grown were Betet Cultivars, which are local superior varieties that are very suitable for local conditions with relatively high seed production (1400 Kg/ha). Soil chemical analysis results of pH, organic C, total N, C/N ratio, total P and CEC in Pati and Asembagus are presented in Tables 5 and 6.
Table 4. Monoculture of mung beans farming (per ha) as intercrops in the Asembagus Sunan candlenut plantation

| No | Physical unit, Per ha | Financial value, IDR/ha |
|----|----------------------|------------------------|
| I. | Production of mung beans, kg | 1400 | 17,500,000,- |
| II. | Production cost of mung bean monoculture : | | |
| 1. | Soil tillage, ha | 1 | 800,000,- |
| 2. | NPK compound fertilizer, kg | 50 | 140,000,- |
| 3. | Urea, kg | 50 | 110,000,- |
| 4. | Mung bean seeds, kg | 4 | 100,000,- |
| 5. | Seeds planting, WD | 6 | 300,000,- |
| 6. | Reseeding of mung bean, WD | 3 | 150,000,- |
| 7. | Weed control I, WD | 10 | 500,000,- |
| 8. | Weed control II, WD | 10 | 500,000,- |
| 9. | Fertilizer application, WD | 5 | 250,000,- |
| 10. | Foliar sprays, DW | 2 | 100,000,- |
| 11. | Pest control, WD | 4 | 200,000,- |
| 12. | Irrigation of mung beans, times | 2 | 200,000,- |
| 13. | Harvest, WD | 15 | 750,000,- |
| 14. | Mung bean grain handlings, WD | 4 | 200,000,- |
| | Total II | | 4,300,000,- |
| Farming Income | I-II | 13,200,000,- |

Note: The price of mung bean seed 25,000 IDR/kg, NPK inorganic fertilizer 2,800 IDR/kg; N, 2,200. IDR/kg, the price of mung beans for consumption 12,500 IDR/kg, male labor wage 50,000 IDR/day, female labor wages 45,000 IDR/day; and 100,000 IDR of irrigation once time, WD = working day.

Table 5 shows that the pH, organic C, total N, C/N ratio, total P and CEC values from low to moderate so that the soil conditions are classified as infertile. Thus, the fertilizer dosage for peanut intercrops is quite large, which is 150 kg N + 100 P2O5 per hectare.

Table 5. Chemical characteristics of Entisol soil in candlenut plantation, Pati Regency

| Soil depth (cm) | pH 1:1 | C- org | N- total | C/N | P- Bray | K | Na | Ca | Mg | CEC | ∑ Cations | BS |
|----------------|--------|--------|----------|-----|---------|---|----|----|----|-----|------------|-----|
|                | pH H2O | pH KCl | %        |     | Mg.     |   |    |    |    |     | %          |     |
| 0-20           | 4.45   | 4.05   | 0.27     | 0.11| 2.50    | 1.69| 0.03| 0.43| 4.19| 0.99| 18.35      | 5.63| 67 |

Notes: CEC= cation exchange capacity; BS=base saturation.

Table 6. Chemical characteristics of Entisol soil in the candlenut plantation, Asembagus

| Soil depth (cm) | pH 1:1 | C- org | N- total | C/N | P- Olsen | K | Na | Ca | Mg | CEC | ∑ Cations | BS |
|----------------|--------|--------|----------|-----|----------|---|----|----|----|-----|------------|-----|
|                | pH H2O | pH KCl | %        |     | mg kg-1  |   |    |    |    |     | %          |     |
| 0-10           | 6.3    | 6.1    | 0.58     | 0.10| 6 | 50.73| 0.99| 2.03| 3.91| 1.10| 8.09| 8.03       | 99  |
| 10-42          | 6.4    | 6.0    | 0.08     | 0.02| 5 | 10.27| 0.50| 1.55| 3.96| 1.15| 7.17| 7.16       | 100 |
| 42-54          | 6.3    | 5.9    | 0.08     | 0.01| 11| 9.49 | 0.52| 1.47| 2.06| 1.05| 5.10| 5.10       | 100 |
| 62-69          | 6.0    | 5.6    | 0.09     | 0.03| 2 | 5.26 | 1.48| 2.60| 12.46| 3.43| 25.17| 19.97      | 79  |
| 69-160         | 6.3    | 6.0    | 0.08     | 0.00| 40| 7.97 | 0.12| 0.48| 0.36| 0.05| 1.01| 1.01       | 79  |

Note: BS= Base Saturation; CEC=cation exchange capacity.
Table 6 shows that Entisol soil with sand-dominated soil texture has a low CEC, pH close to neutral, K, Ca, Mg and Na availability were low, and organic C content and total N of the land were classified as very low. Overall the level of soil fertility were relatively low, so that the management requires input of organic matter and involves intercropping (legume) which were able to fix N2 air and its biomass immersed into the soil [28][29][30][31][32].

4. Conclusion
The candlenut farm integrated with food crops turned out to be very profitable. Revenue of peanut intercropping farming is 24,375,000 IDR/ha. Revenue for corn intercropping farming is 6,080,000 IDR/ha. Revenue of sesame intercropping is 4,510,000 IDR/ha and the revenue of mung beans intercropping are 13,200,000 IDR/ha. B/C ratio of peanuts = 1.93; Value of B/C corn ratio = 2.22; B/C ratio of mung beans = 3.07 and; B/C ratio of sesame = 0.40.

REFERENCE
[1] Herman M and Dibyo P 2011 Karakteristik buah dan minyak kemiri sunan (Reutealis trisperma (Blanco) Airy Shaw) Buletin RISTRI 1 21–2.
[2] Aunillah A and Pranowo D 2012 Karakteristik biodiesel kemiri sunan (Reutealis trisperma [Blanco] Airy Shaw) menggunakan proses transesterifikasi dua tahap. Buletin RISTRI 3 193–200.
[3] Syafaruddin A and Wahyudi 2012 Potensi varietas unggul kemiri sunan sebagai sumber energi bahan bakar nabati Perspektif 11 59–67.
[4] H Holilah, D Prasetyoko, T P Oetami, E B Santos, Y M Zein, H Bahruji, H Fansuri, R Ediati, and J Juwar. 2014. The potential of Reutealis trisperma seed as a new non-edible source for biodiesel production Biomass. Biomass Conversion and Biorefinery 5 347–53.
[5] Pranowo D, Herman M and Syafaruddin 2015 Potensi Pengembangan Kemiri Sunan (Reutealis trisperma (Blanco) Airy Shaw) di Lahan Terdegradasi. Perspektif 14 87–101.
[6] Loos T K 2009 Socio-Economic Impact of A Jatropha-Project on Smallholder Farmers in Mpalda, Tanzania (Stuttgart: University of Hohenheim)
[7] Ariza-Montobbio P, and Lele S 2010 Jatropha plantations for biodiesel in Tamil Nadu, India; Viability, livelihood trade-off and latent conflict Ecological Economics 72 193
[8] Shukla A 2006 Jatropha (Physic Nut) in research frame at Pantnagar Biodiesel Conference Towards Energy Independence-Focus, ed B S M Gen and R Swaminathan (Hyderabad: Ponraj Rashtrapati Bawan)
[9] Favretto N, Stringer L and Dougill A 2012 Cultivating clean energy in Mali: policy analysis and livelihood im-pacts of Jatropha curcas Center for Climate Change Economics and policy (Leeds: The Sustainabily Research Institute) 84 28
[10] Luделing E, Smesthur J, Baudron F, Bayala J, Huth N I, Noordwijk M va, Ong C K, Mulia R, Busiana B, Muthuri C and Sinclair FL 2016 Field-scale modeling of tree–crop interactions: Challenges and development needs. Agricultural Systems 142 51–69
[11] Singh A, Kumar P, Singh R and Rathore N 2012 Dynamics of tree-crop interaction in relation to their influence on microclimatic changes—a review Hort. Flora Res. Spectr. 1 193–8
[12] Gebru H 2015 A review on the comparative advantage of intercropping systems Agriculture and Healthcare 5 28–38
[13] Sastrosupadi A, Widowati and Krismawati A 2019 Prinsip-Prinsip Agromoni Dengan Hasil-Hasil Penelitian di Indonesia (Malang: Univeritas Negri Malang)
[14] Warsawa 2009 Introduksi Teknologi Tumpangsari Jagung, dan kacang Tanah Tabloid Sinar Tani
[15] Handayanto E, Muddarisa N, and Figri A 2017 Pengelolaan Kesuburan Tanah. (Malang: Penerbit Universitas Brawijaya Press)
[16] Haryono B and Mulyaninginsih S 2012 Pengaruh Tumpangsari Terhadap Pertumbuhan dan Hasil Jarak Pagar (Jatropha Curca.L) Hasil Rehabilitasi Berita Biologi 11 1–7
[17] Iijima M, Izumi Y, Yuliadi E, Sunyoto S and Sabe-Ardjasa W 2004 Cassava-based intercropping
systems on Sumatra Island in Indonesia: Productivity, soil erosion, and rooting zone Plant Production Science 7 347–55.
[18] Chai Q, Yu A, Chen G, and Huang P 2011 Soil evaporation under sole cropping and intercropping systems and the main driving factors Chin. J.Eco Agric. 19 1307–12.
[19] Siriri D, Wilson J, Coe R, Tenywa M M, Bekunda M A, Ong C K and Black C R 2013 Trees improve water storage and reduce soil evaporation in agroforestry systems on bench terraces in SW Uganda. Agrofor. Syst. 87 45–8
[20] An T, Li C, Hu B W C and Zheng A 2007. Effect of different intercropping measures about soil and water loss on sloping land Soil Water Conserv 5 1824
[21] Fan Z, An T, Wu K, Zhou F, Zi S, Yang Y, Xue G, Wu B 2016 Effects of intercropping of maize and potato on sloping land on the water balance and surface runoff Agricultural Water Management 166 9–16.
[22] Al-Dalain S A 2009 Effect of intercropping of zea maize with potato Solanum tuberosum, L. on potato growth and on the productivity and land equivalent ratio of potato and Zea maize. Agric. J. 4 164–70.
[23] Khan Z R, Ampong-Nyarko K, Chiliswa P, Hassanali A, Kimani S, Lwande W, Overholt W A, Picketta J A, Smart L E and Woodcock C M 1997 Intercropping increases parasitism of pests. Nature 388 631–2.
[24] Khan Z R, Hassanali A, Overholt W, Khamis T M, Hooper A M, Pickett J A, Wadhams L J and Woodcock C M 2002 Control of witchweed Striga hermonthica by intercropping with Desmodium spp., and the mechanism defined as allelopathic Journal of Chemical Ecology 28 1871–85
[25] Ramert B, Lennartsson M, and Davies 2002 The use of mixed species cropping to manage pests and diseases—theory and practice Proceedings of the UK Organic Research 207–210.
[26] Trdan S, Žnldarčič D, Valič N, Rozman L, and Vidrih M 2006 Intercropping against onion thrips, Thrips tabaci Lindeman (Thysanoptera: Thripidae) in onion production: on the suitability of orchard grass, lacy phacelia, and buckwheat as alternatives for white clover Zwischenfruchtanbau zur Kontrolle des Zwiebelthrip. Journal of Plant Diseases and Protection 113 24–30.
[27] Opunlola A I 2009 Effect of mixed-cropping on field insect pests of leaf vegetables in southwest Nigeria. Advances in Horticultural Science 23 259–62.
[28] Bhatti A U, Gurmani Q U A H and Khan M J 2005 Effect of organic manure and chemical amendments on soil properties and crop yield on a salt affected Entisol. Pedosphere 15 46–51.
[29] Tanimu J, Iwuafor E N O, Oduenze A C, and Tian G 2007 Effect of Incorporation of Leguminous Cover Crops on Yield and Yield Components of Maize World Journal of Agricultural Sciences 3 243–9
[30] Egbe O M and Ali A 2010. Influence of soil incorporation of common food legume stover on the yield of maize in sandy soils of Moist Savanna Woodland of Nigeria. Agriculture and Biology Journal of North America 1 156–62.
[31] Rumpel C and Kögel-Knabner 2011 Deep soil organic matter—a key but poorly understood component of terrestrial C cycle Plant and Soil 338 143–58.
[32] Zulkarnain M, Prasetya B, and Soemarno S 2013 Pengaruh kompos, pupuk kandang, dan custom bio terhadap sifat tanah, pertumbuhan dan hasil tebu (Saccharum officinarum L.) pada Entisol di Kebun Ngrangkah-Pawon, Kediri. The Indonesian Green Technology Journal 2 45–52.

