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# ECONOMICS OF PHYSIC NUT (*Jatropha curcas L)* AS INFLUENCED BY PROPAGATION METHODS, NITROGEN LEVELS AND WEED CONTROL AT SAMARU, NIGERIA.

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## ABSTRACT

The effect of propagation methods, level of nitrogen application and weed control methods on profitability of *Jatropha curcas* was examined using Gross margin analysis. Field trials were conducted during the 2008, 2009, 2010 and 2011 farming seasons at the Institute for Agricultural Research (I.A.R) research farm Samaru ($11^o$ $11^1$ N; $07^o$ $38^1$ E and 686m above sea level) to compare the economic benefit of propagation methods, level of nitrogen application and weed control methods on growth of Physic Nut using Gross margin analysis. The treatments consisted of two propagation methods of seeds and stem cuttings, four weed control treatments (Fusilade plus Diuron at 1.0 + 0.8 kg a.i $ha^{-1}$, applied at 4 and 12 weeks after transplanting (WAT), followed by supplementary hoe-weeding at 16 WAT; Atrazine plus Diuron at 1.0 + 0.8 kg a.i $ha^{-1}$, applied at 4 and 12 WAT, followed by supplementary hoe-weeding at 16 WAT; hoe weeded at 4,8,12 and 16 WAT and a weedy check) and three levels of nitrogen ( 0, 50 and 100kg $ha^{-1}$). The treatments were laid out in a split-plot design and replicated three times. Nitrogen levels and weed control treatments were assigned to main plots while the propagation methods were assigned to the sub plots. The results indicated that the highest gross margin of ₦34, 386.08k was obtained by propagating physic nut through stem cuttings at a combinations of 100kg $Nha^{-1}$ and post-emergence application of Atrazine plus Diuron at 1.0 + 0.8 kg a.i. $ha^{-1}$, followed by supplementary hoe weeding at 16 weeks after.

**Keywords:** *Economics, physic nut, propagation methods, Nitrogen levels and weed control*

## INTRODUCTION

Physic nut (*Jatropha curcas*) belongs to the family *Euphorbiaceace* and originated from the Carribbean, Central America and was spread by Portuguese traders as a valuable hedge plant via the Cape Verde Islands and former Portuguese Guinea (Henning, 2000) to countries in Africa, Asia and India (Jepsen *et al*., 2006).Currently, it grows throughout the arid, semi-arid, tropical and subtropical regions of the world where it has since been adapted and widely utilized on a local basis (Jones and Miller, 1992, Hikwa, 1995, Henning, 1996; Makkar *et al*., 1997). In Nigeria, it is found growing as a live fence / hedgerow and for medicinal purposes with different local names, which shows its spread throughout the country. It is referred to as "*Lapalapa*" by the Yorubas, "*Binida zugu*" by Hausas and "*Okwenwe*" by the Ibos.

The leading producing the world are Central and Latin America, Southern Africa and Mali. Seed production in semi-arid areas varies between 2.5 t/ha and 5t/ha depending on whether the soils are poor or rich. If planted as hedges, productivity ranges from 0.8kg to 1kg of seed per meter of live fence (Heller, 1996; Satish Lele, 2007). Mabelle (2007) reported that yield of physic nut per hectare in Philippines ranges from 1.2 to 1.25 t depending on the site, climate and management of the plant.

The most important use of physic nut today is the use of its oil as bio-diesel in diesel engines after trans-esterification to replace a portion of the country's dependence on imported oil. Using physic nut oil for biodiesel reduces greenhouse gas emissions due to its low sulphur emission. Physic nut bio-diesel is as good as diesel fuel in terms of engine performance; it readily mixes with diesel fuel and runs in any diesel engine without modification. Diesel from physic nut is renewable. The non-edible physic nut oil has requisite potential of providing a promising and commercially viable alternative to petro-diesel (Bio-energy programming, 2007).The world's annual bio-diesel production is about 3,500 million litres (William, 2006). According to the International Institute for Environment and Development, world bio-diesel production is expected to quadruple to over 120,000 million litres by 2020, accounting for about 6 percent of 3 percent of world motor petroleum use and total road energy use respectively.

Physic nut plant has many uses the latex contains an alkaloid known as "jatropure" which is believed to have anti cancerous properties and stops bleeding. The latex is also used as an external application for skin diseases and rheumatism. The roots are reported to be used as an antidote for snake bite, while the root extract can be used as yellow dye. Its poor palatability and high tanins content makes it a good live fence. Such as live fence, due to its poor palatability and high tannin level (Mapako, 1998, Gour, 2004; Sharma *et al*., 1995; Wegmershaus and Oliver, 1997 Bio- energy Programme, 2007).

The cultivation of physic nut in Nigeria is sporadic and confined to its use in traditional medicines and as hedgerow by the rural farmers in all parts of the country. Many farmers in Nigeria are unaware that physic nut is gaining attention as an important bio-diesel crop throughout the world, and of the numerous industrial, pharmaceutical, environmental and other uses of physic nut. Although it is known that physic nut can be established from seed, seedlings and vegetative from cuttings, very little written information is available about the silviculture and management of physic nut. The absence of quality germplasm and the poor understanding of its soil fertility requirement and agronomics may result in poor production. In the current farming and economic environment, gross margin analysis is a very important tool to determining the level of farm profitability (Firth c and Lenartson 1999). A gross margin is simply the difference between the gross income earned by an enterprise and the variable costs of production. (Erabor, 2005)

Knowing the gross margin of crops grown is a good planning tool that helps to determine how much the different enterprise options are capable of generating. Gross margin analysis provides a guide to the relative profitability of different improvement options and helps to decide whether a potential improvement is worth implementing, or whether one option is better than another option (Firth c and Lenartson 1999). This study therefore, assessed the profitability of individual factors employed (agronomical concept; propagation method, nitrogen levels and weed control methods using the gross margin analysis ) in physic nut production. The specific objective was to determine the cost and returns of physic nut production for different treatments.

## MATERIALS AND METHODS

The research was conducted at the farm of the Institute for Agricultural Research Samaru in 2008 - 2011 wet and dry seasons. The treatment consisted of two propagation methods (seeds and stem cuttings), four weed control treatments (Fusilade plus Diuron at 1.0 + 0.8kg a.i/ha applied at 4 and 12 weeks after transplanting (WAT), followed by hoe weeding at 16WAT; Atrazine plus Diuron at 1.0 + 0.8kg a.i/ha applied at 4 and 12 WAT, followed by hoe weeding at 16WAT; hoe weeded control (4, 8, 12 and 16 WAT) and a weedy check) and three levels of nitrogen fertilizer (0, 50 and 100kg N ha-1)

The treatments were laid out in a split plot design, replicated three times. Nitrogen levels and weed control treatments were assigned to the main plot, while propagation method was assigned to the sub-plots. The gross plot size was 6m long by 6m wide (36 $m^2$), while the net-plot size was 2m wide by 6m long (12$m^2$).The border between plots and replicate were 2m and 3m respectively.

Top soil, river sand and well-rotted farm yard manure were mixed in ratio 3:2:1 by volume. Filled black polythene bags were watered before direct sowing of physic nut seeds at two seeds per polythene bag at a planting depth of 3cm (Singh *et. al*., 2007) and planting of the 30cm cuttings having 4-6 buds at 10cm depth at a cutting per bag simultaneously on 4$^{th}$ March, 2008. Thinning was done 2 weeks after seed emergence. Watering was carried out every other day until rain established.

Transplanting of physic nut seedlings and stem cuttings were done simultaneously at 12 weeks of age according to treatments on the 2nd June, 2008 at one seedling and a cutting per hill at spacing of 2 x 2m, giving plant population of 2,500ha$^{-1}$.

Urea (46% N) was applied to supply nitrogen as per treatment in two equal doses; SSP and MOP were applied as basal to the crop at 30kgha-$^{1}$ yearly to supply phosphorus and potassium.

Both herbicides treatments were applied as post-emergence directed spray using a CP3 knapsack sprayer fitted with a green deflector nozzle, followed by supplementary hoe weeding respectively. The control plots were hoe weeded according to treatment same day both herbicide treatments were imposed for other treatments.

Yellow and brown to black capsules were harvested fortnightly by hand picking in 2009, 2010 and 2011. No yield was recorded in 2008 because the plants did not bear fruits.

Yield data collected was subjected to analysis of variance as described by Snedecor and Cochran (1967). The treatment means were compared using Duncan's Multiple Range Test (DMRT) (Duncan, 1955). Gross Margin was used to determine the economic returns of Physic nut production using the model below:

GM = TR – TVC

Where, GM = Gross margin

TR = Total revenue

TVC = Total variable costs ( fertilizer, labour, cost of seeds)

**RESULTS AND DISCUSSION.**

The results in Table 1 shows the effects of propagation method, nitrogen levels and weed control methods on seed yield ha$^{-1}$. The effects of propagation method was significant only in 2009, where plants raised from stem cutting produced higher seed yield ha$^{-1}$ than those raised from seed. Nitrogen level significantly affected seed yield during the four years of experimentation. Each increase in N level from 0 – 100 kg. ha$^{-1}$, resulted in consistent and significant increase in seed yield.

The effect of weed control method on seed yield was also significant during the four years of investigation. POE application of Atrazine plus Diuron application at 1.0 + 0.8 kg a.i.ha$^{-1}$ and hoe weeding resulted in significantly higher seed yield. Similarly, significantly lower seed yield ha$^{-1}$ was recorded in the the weedy check than on plots treated POE with Fluazifop plus Diuron at 1.0 + 0.8 kg a.i.ha$^{-1}$.

The interaction effect of nitrogen levels and weed control methods were significant on seed yield in 2009 and 2010 (Table 2). It was observed that for all weed control methods, increase in N level from 0-100 kg N. ha$^{-1}$ significantly increased seed yield except at the weedy check plots which produced similar seed yield between the plots applied with 50-100 kg N. ha$^{-1}$ in 2010. However, in 2009, seed yield increased with increasing nitrogen application from 0-100 kg N. ha$^{-1}$ which was significantly higher than the control. Generally, plots treated POE with Atrazine plus Diuron at 1.0 + 0.8 kg a.i.h$^{-1}$and100 kg N. ha$^{-1}$ had the highest seed yield in both years, particularly in 2010 when the difference was distinguished.

The gross margin analysis of physic nut cultivated with propagation method, nitrogen levels and weed control method from 2008 -2011 at Samaru and various cost incurred in the course of production and the revenue obtained from sales were computed based on the prevailing, average lowest market prices at the time of production (Table 3).

The result of gross margin indicated that the highest gross returns of ₦34,386.8 was achieved by propagating physic nut through stem cutting at a combinations of 100kg N ha$^{-1}$ and post-emergence POE application of Atrazine plus Diuron at 1.0 + 0.8 kg a.i. ha$^{-1}$ fb supplementary hoe weeding at 16 weeks after. A net loss of about N1,737 was observed from combinations of seeds, post-emergence POE application of fluazifop plus Diuron at 1.0 + 0.8 kg a.i. ha$^{-1}$ fb supplementary hoe weeding at 16 weeks after and with zero nitrogen application.

**DISCUSSIONS**

Physic nut propagated through stem cuttings recorded significant higher yield than plots propagated through seeds. This observation could be due to early establishment of the stem cuttings, higher branching ability due to its existing buds, which in turn resulted to more fruits bearing points.

Seed yield of 61.66, 92.59 and 102.55kg $ha^{-1}$ observed with Atrazine plus Diuron treatments in 2009, 2010 and 2011, respectively which were similar to only hoe-weeding could be directly related to the fact that the combined application gave broader spectrum and season long weed control method than Fluazifop plus Diuron treatment that suffered weed competition resulting to significant yield reduction recorded, though statistically superior to the weedy check, the percent seed yield losses encountered due to uncontrolled weed interference during the study were 82.2%, 74.6% and 72.9% in 2009, 2010 and 2011 respectively implying that seed yield was significantly reduced in the weedy check, followed by Fluazifop plus Diuron, probably due to severe weed competition for light, nutrient and moisture during both vegetative and reproductive period of the crop life cycle. Weed interference in crop is known to reduce crop yield and affect yield components (Akobundu, 1987).

The significant interaction between nitrogen levels and weed control methods on seed yield showed the importance of nitrogen as both doses of fertilizer treatments exhibited increased yield in comparism with the control. This result agrees with the finding of Raju and Sinsinvar (2006) who reported that castor growth and yield were significantly influenced by nitrogen application.

Significantly higher seed yield (50.16, 80.71 and 89.5kg $ha^{-1}$) were obtained with the application of 100kg N $ha^{-1}$ compared with 50kg N $ha^{-1}$ (41.96, 67.22 and 77.14kg $ha^{-1}$) in 2009, 2010 and 2011, respectively. The increase in yield with application of 100kg N $ha^{-1}$ was to an extent of 54.5, 54.6 and 53.7% over 50kg N $ha^{-1}$ in 2009, 2010 and 2011, respectively while increase in yield with 50kg N $ha^{-1}$ over the control were 62, 60.9 and 58.6%, respectively over the years. This was because an increase in nitrogen application positively enhances the chlorophyll content in plant thereby improving photosynthetic activities that promotes assimilating production (Akinpola, 1987). The positive influence of fertilizers, particularly, the nitrogen components on vegetative growth of plants is a well-known fact in upgrading the nutrient status of poor soils *al.*1978).

Considering the cost and returns analysis, the acceptance of generated technology by the farmers ultimately depends on the benefits expected this present study, the net returns of physic nut seed yield greatest the combinations of stem cuttings, 100kg N $ha^{-1}$ and post –emergence POE application of Atrazineplus Diuron at 1.0 + 0.8 kg a.i. $ha^{-1}$ fb supplementary low-weeding at 16 weeks after as compared to other treatments combinations. This could be attributed to better adaptability of the stem cuttings and the high nitrogen level (100kg N $ha^{-1}$) which accelerated photosynthetic rate leading to more production of carbohydrates and improvement in growth and yield attributes (Taylor *et al.*,2005), resulting in increased returns and profitability. The highest gross margin per hectare or per plot of ₦34, 388.8 produced with the combination of Atrazine plus Diuron could be a clear indication of the effectiveness of the weed control method treatment and timeliness of the operations over the other weed control measures. It also resulted in higher profitability of the herbicide treatment than the hoe-weeding. Moreover, the drudgery involved in weeding and non-availability of labour can be avoided when herbicides are used at this recommended rate. However, lower net returns was recorded from combinations of propagation by seeds, zero nitrogen and post-emergence POE application of fluazifop plus Diuron at 1.0 + 0.8 kg a.i. $ha^{-1}$. This result is in conformity with the findings of Veena (2008), who reported significantly higher net returns with application of 100: 100. 150 kg N, $P_2O_5$, $K_2O$ $ha^{-1}$ to *Jatropha* as compared with other treatment combinations.

Table 1: Effects of propagation method, nitrogen level and weed control method on the seed yield kg ha $^{-1}$ of physic nut at Samaru.

| | | **Seed yield kg ha $^{-1}$** | | |
|---|---|---|---|---|
| **Treatments** | **Rate (kg a.i. ha$^{-1}$)** | **2009** | **2010** | **2011** |
| **Propagation method (P)** | | | | |
| Stem cuttings | | 43.18a | 64.89 | 74.23 |
| Seeds | | 35.38b | 62.52 | 73.14 |
| SE ± | | 1.076 | 2.360 | 2.530 |
| **Nitrogen (kg N ha $^{-1}$)** | | | | |
| 0 | | 25.72c | 43.18c | 54.42c |
| 50 | | 41.96b | 67.22b | 77.14b |
| 100 | | 50.16a | 80.71a | 89.50a |
| SE ± | | 1.131 | 1.708 | 3.874 |
| **Weed control method (W)** | | | | |
| Fluazifop + Diuron | 1.0 + 0.8 | 29.78b | 49.66b | 61.83b |
| Atrazine + Diuron | 1.0 + 0.8 | 61.66a | 92.59a | 102.55a |
| Hoe weeded | | 60.31a | 90.98a | 100.24a |
| Weedy check | | 13.37c | 31.59c | 38.14c |
| SE ± | | 1.307 | 1.973 | 4.474 |
| **Interaction** | | | | |
| N x W | | * | * | NS |
| N x P | | NS | NS | NS |
| W x P | | NS | NS | NS |
| N x W x P | | NS | NS | NS |

Means in a column of a set of treatment followed by same letter(s) are significantly not different P≤ 0.05 level of probability using DMRT. NS=Not significant.

Table 2: Interaction between nitrogen level and weed control method on seed yield (kg ha$^{-1}$) of physic nut in July 2009 & 2010 at Samaru.

| | **Weed control method (W)** | | | |
|---|---|---|---|---|
| **Treatment** | **Fluazifop + Diuron** | **Atrazine + Diuron** | **Hoe weeded** | **Weedy check** |
| **2009 harvest** | | | | |
| **Nitrogen (kgN ha$^{-1}$)** | | | | |
| 0 | 17.73d | 42.85b | 41.16b | 6.15e |
| 50 | 26.69c | 69.25a | 67.64a | 14.25d |
| 100 | 44.93b | 72.88a | 70.14a | 19.71d |
| SE ± | | 2.264 | | |
| **2010 harvest** | | | | |
| **Nitrogen (kgNha $^{-1}$)** | | | | |
| 0 | 33.89e | 66.92c | 65.79c | 19.11f |
| 50 | 51.72d | 96.08b | 97.58b | 33.50e |
| 100 | 63.36c | 114.76a | 102.57a | 42.16de |
| SE ± | | 3.417 | | |

[1] Within month, means followed by same letter(s) are not significantly different (P≤ 0.05) using DMRT.

Table 3: Gross Margin Analysis of Physic Nut Cultivated Under Propagation Methods, Nitrogen Levels and Weed Control Methods at Samaru. (2008-2011)

| **Treatments** | **Product cost (₦)** | **Yield (kg/ ha)** | **Unit price (₦/kg)** | **Total revenue (₦)** | **gross margin (₦/ha)** |
|---|---|---|---|---|---|
| NOW1P1 | 15,270 | 90.22 | 150 | 13,533 | -1,737 |
| NOW1P2 | 15,280 | 107.99 | 150 | 16,198.5 | 918.5 |
| NOW2P1 | 14,930 | 197.89 | 150 | 29,683.5 | 14,753.5 |
| NOW2P2 | 14,940 | 176.66 | 150 | 26,499 | 11,559 |
| NOW3P1 | 17,310 | 195.55 | 150 | 29,332.5 | 12,022.5 |
| NOW3P2 | 17,320 | 178.86 | 150 | 26,829 | 9,509 |
| NOW4P1 | 8,610 | 47.20 | 150 | 7,080 | -1,530 |
| NOW4P2 | 8,620 | 51.94 | 150 | 7,791 | -829 |
| N1W1P1 | 15,482.56 | 143.43 | 150 | 21.514.5 | 6,031.94 |
| N1W1P2 | 15,492.56 | 150.80 | 150 | 22,620 | 7,127.44 |
| N1W2P1 | 14,472.56 | 263.50 | 150 | 39525 | 25,052.44 |
| N1W2P2 | 14,482.56 | 272.06 | 150 | 40,809 | 26,326.44 |
| N1W3P1 | 18,872.56 | 262.76 | 150 | 39.414 | 20,541.44 |
| N1W3P2 | 18,882.56 | 271.71 | 150 | 40,756.5 | 21.873.94 |
| N1W4P1 | 8,822.56 | 82.97 | 150 | 12,445.5 | 3,622.94 |
| N1W4P2 | 8,822.56 | 94.98 | 150 | 14,247 | 5,424.44 |
| N2W1P1 | 15,695.2 | 163.13 | 150 | 24,469.5 | 8,774.3 |
| N2W1P2 | 15,705.2 | 191.25 | 150 | 28,687.5 | 12,982.3 |
| N2W2P1 | 15,345.2 | 295.83 | 150 | 44,374.5 | 29,029.3 |
| N2W2P2 | 15,185.2 | 330.48 | 150 | 49.572 | 34,386.8 |
| N2W3P1 | 19,085.2 | 294.82 | 150 | 44,223 | 25,137.8 |
| N2W3P2 | 19,095.2 | 326.42 | 150 | 48,963 | 29,867.8 |
| N2W4P1 | 9,035.2 | 102.88 | 150 | 15,432 | 6,396.8 |
| N2W4P2 | 9,045.2 | 119.13 | 150 | 17,869.5 | 8,824.3 |

Source: Field experiment 2008-2011. IAR ZARIA

## CONCLUSION

It is best and economical to produce physic nut through stem cutting at a combinations of 100kg N $ha^{-1}$ and post-emergence application of Atrazine plus Diuron at 1.0 + 0.8 kg a.i. $ha^{-1}$ fb supplementary hoe weeding at 16 weeks. It is therefore recommended for farmers and prospective investors.

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