



## Optimal Farm Plan for the Tree Crops Production Under Small-Scale Irrigation in Fadama Areas of Niger State, Nigeria

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### Abstract

This study determined the Optimal farm plan for *Fadama* tree-crop farmers in Niger State, Nigeria. For the study, 120 *Fadama* tree-crop farm households were randomly selected and interviewed with the use of interview schedule accompanied by well structured questionnaires. Descriptive statistics and Linear programming (L.P) model were used to analyse the data. The result reveals that *Fadama* tree-crop farmers had small land holdings which were rented on a long term basis. Most of the household heads were males (98.3%) and having an average household persons size of 9 persons on average. The head of the households also had one form of modern education or the other (73.3%). Similarly, they also had tree-crop farming experience of about 8 years on average. The result of the LP analysis shows that only orange (*Citrus Lemon*) enterprise should be carried out on a 0.712ha of farm land as this will yield an optimal return of N78,989.48 per hectare per year. However, capital was the only limiting resource in the study area and has a shadow price of N8.453k. Many problems constrained the use of *Fadama* resource for tree crop production in the area and these were ranked in order of importance, including limited fund, conflicts among its users, incidence of pests and disease infestation and land tenure problem. The study therefore recommends that farm families should direct their resources towards the production of only *Citrus lemon*, and both governments and non-governmental organizations should assist in providing infrastructure and soft loans to farm families engaged in tree-crop production in the area.

**Keywords:** *Fadama*, Small-scale irrigation, Optimal farm plan, Tree crops and Shadow price

### Introduction

The word *Fadama* is said to be a Hausa word which refer to low-lying relatively flat areas in streamless depressions or adjacent to seasonally or perennially flowing streams or rivers (Kolawole and Scoones, 1994). According to Abdullahi *et al.* (2007), *Fadama* is a low lying alluvial and partially or completely flooded during wet seasons. Similarly, Akinleye *et al.* (2006) asserted that the word *Fadama* means flood plains and low-lying areas underlined by shallow aquifers. World Bank (1992) also defined *Fadama* as a Low-lying flood plains consisting of fluvial deposits with extensive exploitative aquifers, ideal for irrigated crop production. It has characteristic moisture retention capacity within a very close to rhizosphere and fertility for greater part of the year than the adjacent upland (Kolawole and Scoones, 1994).

It is the relative wetness, dryness and the seasonal and inter annual variations of the moisture level of the top and bottom components of the system that are particularly important from the point of view of environmental resources management. *Fadama* are known to hold great potentials for the production of important grain crops, forest crops and vegetables in quantities large enough to at least meet domestic demand if they are adequately exploited and managed. They help in stabilizing production in Northern parts of the country with marginal rainfall (Ismail, 2004). Similarly, Small-scale irrigation in *Fadama* as opposed to large-scale irrigation of the RBDAs (River Basins Development Authorities) has been identified as a source of agricultural growth and development (Ndanitsa, 2005).

*Fadama* irrigation farming has a long history in Nigeria, most especially in the northern part where farmers have traditionally undertaken irrigation through the use of technologies and methods as shadouf, buckets and calabash to produce high value crops like maize, rice, sugar cane, cocoyams, leafy vegetables, tree crops and other crops in diverse cropping system (Ismail, 2004). Amongst these tree cropping systems, most farmers tend to prefer Orange (*Citrus lemon*), Mango (*Mangifera indica*), Guava (*Pisium guajara*) and Pawpaw (*Carica papaya*), probably because of their ease of establishment and minimum silvicultural requirements, as well as adaptability to the ecological zone. This Farmer's preference to these tree crops could more so be attributed to the availability of high yielding hybrid varieties closet to their vicinity.

Furthermore, the *Fadama* tree crop plantation is a very lucrative economic activity as this provides cash income as well as food crops to its growers. This identifies *Fadama* as a critical resource within the area, and other semi-arid Northern Nigeria. In Niger State, *Fadama* tree crop production is a common cropping system in almost all the State's lowland areas. The production of *Fadama* tree crops is a component of *Fadama* farming system in Niger State where irrigation is being practiced (African Development Fund Report, 2004). However, a critical assessment of the performance of *Fadama* tree crop farming in Niger State reveals that the sub-sector is bedeviled with a number of technical, financial, institutional and human resource challenges which submerged these farmers persistently in the vicious cycle of poverty due to low income from low productivity, consequent of low investment opportunities. The study therefore seeks to provide answers to the following research questions. Is *Fadama* tree crop production a profitable venture? Could the decline in tree crop production be attributed to lack of optimum farm plan/combination in the use of the resources? What are the problems affecting tree-crop production under *Fadama* irrigation? The study's objective therefore is to develop an optimum farm plan for tree crop farming system under the *Fadama* irrigation and to identify the constraints encountered by the *Fadama* tree crop producers in the area.

This study is a timely one since tree crop production is one of the sub-sectors identified for the commercial agriculture in the transformation agenda of the present administration to ensure food security, self sufficiency in food production and self-reliant in the economy (Jonathan, 2010). Within the study area many tree crop farmers combine these crops as a means of reducing production risk associated with their production. Thus, to determine whether such combination accrue any benefits to the farmers most especially the *Fadama* farmers is of paramount importance. This is more so since *Fadama* avails the farmer more benefits. *Fadama* have more agricultural potentials than the adjacent uplands (Baba, 2004). It is also useful to develop an optimum farm plan for *Fadama* crop farmers that will be profitable and sustained for a very long period of time by the user in specific situations. For example, Ogunfowora (1970) studied the potential role of farming in the food production sector of Nigerian Agricultural Industry. Two models were designed and tested. The first model was designed to characterize the peasant farm operating entirely on subsistence basis while the second model characterized a family farm with commercial orientation in the sense of incorporating labour hiring and capital borrowing.

## Methodology

### Study area

The study was conducted at the Niger State *Fadama* Areas, which are along the flood plains of River Niger and River Kaduna. The study data was gathered during the 2008/2009 cropping season in the state. The *Fadama* tree-crop cultivation is carried out by small scale farmers who are mostly migrants from the neighbouring states of Kaduna, Kebbi, Sokoto and Zamfara. *Fadama* farming in Niger State is practiced in low valley areas that are usually waterlogged during the rainy seasons. These areas also retain moisture and are more productive even without any investments for irrigation agriculture during the dry season periods. They are therefore used for the cultivation of crop, including tree crops. The tree crops constitute an important source of income as well as a risk integrating mechanism, in that they serve as complement food in years of poor rainfall or harvest from arable crops.

### Sampling technique and data collection

The sampling size was 120 farm household respondents. The choice of this number was on the basis of the preliminary survey of the study area. The target population for the study is the *Fadama* tree crop farm households in Niger State. The sampling procedure comprised a three stage sampling technique. The first stage involved random selection of two (Mokwa and Shiroro) out of the Local Government Areas (LGA) in Niger State where *Fadama* tree crop farming is popular. The thirteen LGAs known for *Fadama* tree crop farming in Niger State are Mariga, Mokwa, Chanchaga, Shiroro, Lavun, Munya, Gbako, Lapai, Suleja, Agwara and Wushishi (NSFDO, 2010). The second sampling stage comprised random selection of six localities (villages) each from selected LGAs, while the third stage is the random selection of 10 *fadama* tree crop farm households per selected localities. The study respondents therefore totaled 120 farm household respondents. However, the choice for villages was premised on the fact that *Fadama* farming and agricultural activities in general is essentially a rural activity (Baba, 2004).

Data for this study were sourced majorly from primary sources. The primary data were gathered using interview guide with aid and of a well structured questionnaires to solicit responses from respondents. Data collected were those on the socio-economic characteristics of respondents, such as those on types of crops grown, farm size, age and household size. Other information gathered were those on the production resources and farm output during the 2008/2009 production season.

### Analytical tool

Descriptive Statistics such as means (averages), tabulations, frequency distribution and percentages were used in the analyses of the socio-economic characteristics of the farmers.

These enterprises include:

- $X_1$  = Orange (*Citrus lemon*)
- $X_2$  = Mango (*Mangifera indica*)
- $X_3$  = Guava (*Pisium guajava*) and
- $X_4$  = Pawpaw (*Carica Popaya*)

The activities were defined in units of one hectare (1 ha), for each of the enterprises

The Linear programming model. LP lined was estimated, thus:

$$\text{Max } Z = \sum (P_j q_j - C_j) \text{ ----- (i)}$$

$$= \sum_{j=1}^m a_{ij} X_j \leq B_i \text{ ----- (ii)}$$

$$= X_j \geq 0 \text{ (j = 1 - m) ----- (iii)}$$

Where  $Z$  = Returns to owners labour and management (N/ha)

$P_{ij}$  = Price of  $ij^{\text{th}}$  crop per unit (=N=)

LP model was however used to develop the optimal farm plan for the tree-crop farmers in the area. The various levels of constraints were determined by what the representative farmers in the study area had. According to Okuneye (1985), a representative farm can be used to depict a farm in sample. A representative farmer was taken to be the farmer who used the arithmetic mean of each of the resources as their components can be found on majority of the farms they represent. For example, the LP model emphasized the followings:

**Land constraint:** Represent the arithmetic mean of land cultivated by the farmers in the area, and was measured in hectares (ha).

**Labour Constraint:** Aggregated family, communal and hired labour measured in man days was obtained and the total labour used per hectare must be less than or equal to this value. A man-day refers to an average man working for eight (8) hours/day.

**Capital constraint:** The maximum own capital available was obtained by determining the arithmetic mean of farmers expenses (costing capital items) or purchase used inputs like chemical fertilizers pesticides, seeds/seedlings etc. The mean capital develop to each tree crop was determined and summed up to obtain the total capital used in the study area.

**Supplementary Irrigation input constraint:** Supplementary irrigation was carried out by the farmers during the off-season. The average water input expressed in hectare centimeter (ha-cm) was similarly obtained.

Furthermore, the basis activities in the use refer to the various tree-crop enterprises carried out by the farmers. However, only those enterprises carried out by up to 6 per cent of the total respondents were considered appropriate for the analysis (Muhammad-Lawal, 2004).



|                 |       |   |  |
|-----------------|-------|---|--|
|                 | $Q_j$ | = | Quantity of $j^{\text{th}}$ Crop (kg)                            |
|                 | $C_j$ | = | Total variable costs of labour and purchased inputs              |
| $a_{ij}$        |       | = | per unit requirement of the $j^{\text{th}}$ activity carried out |
| $m$             |       | = | The number of activities and it ranges from 1 - 4                |
| $j^{\text{th}}$ |       | = | Resources; ranges from 1 - 4                                     |
| $b_i$           |       | = | The level of $j^{\text{th}}$ resources                           |
| where $b_1$     |       | = | Average farm size (ha)   |
| $b_2$           |       | = | Average capital employed per farmers (₦/ha)                      |
| $b_3$           |       | = | Average water input (from supplementary irrigation) (ha-cm).     |

## Results and Discussion

### Socio-economic characteristics of Respondents Household

Table 1 presents the socio-economic characteristics of *Fadama* tree-crop farmers in the study area. Almost all the households (98.3% were headed by male whose average was 9 persons. The large household size could imply a probable more family labour and a consequent greater plantation output for the foresters. However, Baba and Etuk (1993) and Baba and Wando (1998) explained that, the implication of the large family size is that family expenditure tends to draw more on family income so that only a meager amount is saved and invested eventually in farming. Majority of the farmers (40%) were aged: on average 46 years while their model age bracket was 41 - 50.

The small percentage of the foresters (tree-crop farmers) could be due to the migration of the able-bodied youths to the urban towns/cities in search of white collar jobs and quest for formal education training. Forestry served as farmers' major occupation with most household head (70%) having about 8 years of farming experience on average. Thus, tree-crop farming is still in its infant stage in the study area. Most of the farm household head (73.3%) were literate with one form of education or the education. This development could have a positive impact on the productivity of the foresters in the area as most of the farmers could possibly read and write, and by implication can easily be educated on skills acquisition to improve on their performance which could translate to increased productivity and income (Binswanger and Rosenzweig, 1996). However, about 26.7% of the household heads in the study area had acquired no form of formal education. These findings did not concur with Adewumi *et al.* (2005), that although *Fadama* farmers are educated with one form of education or the other, majority of them do not have primary education. Moreso, in spite of high level of literacy (which

is predominantly due to modern education stitches), foresters have little or no record kept.

As shown in Table 2, only orange (*Citrus lemon*) activity/enterprise should be carried out on a 0.712ha of the *Fadama* farm land in the study area. This is capable of yielding an optimal farm income to the households of ₦78,989.48/ha. Furthermore, Table 3 revealed that capital is the most limiting resource constraint in the enterprise carried out in the *Fadama*. It has a shadow price of ₦8,453, but other resources (Land, Labour and Supplementary irrigation water) are in surplus.

### Constraints to *Fadama* tree-crop production

The constraints to *Fadama* tree-crop production were the problems limiting *Fadama* tree-crop farming in the study area. These constraints are as ranked in Table 4. The analyses of constraints to *Fadama* tree crop production reveals that pests and diseases ranks foremost followed by capital (limited funds), problem of flood, limited labour supply (especially hired labour), poor road network, conflict amongst the *Fadama* resource users respectively. The results on the prominent pests and diseases infestation of *Fadama* lands agree with Abdullahi (1980) and Ndanitsa (2005), who both in their separate studies revealed that the continuous moisture of *Fadama* farms provided favourable conditions for the build-up of disease agents such as fungi, nematodes and bacteria. Another important problem was inadequate funds (which the LP summary also reveals as the limiting factor in tree-crop production under *Fadama*). This problem denied the *Fadama* foresters the opportunity to capitalize their *Fadama* enterprise. To buttress this finding,

Ayinmodu (2002) reported that one of the factors responsible for the poor performance of crops under *Fadama* cultivation in Nigeria includes poverty on the part of the farmers. This problem ranked second. Flooding also was another important problem.

Farmers attributed the flooding problems to the opening-up of dams (Kainji dam, Jebba dam and Shiroro dam) upstream, thus conforming with the findings of Reijnters *et al* (1992) statement that flood is a major problem of wetland utilization, and ranked fourth among the myriad of problems. Inadequate labour supply is another serious problem of *Fadama* users, especially the farmers. Its high cost and scarcity at peaks of farm work during the season was also a major constraint reported.

Furthermore, another problem is the non-accessibility of the *Fadama* farm lands especially during the rains. Most of the farm plots were located 3 – 8 kilometers away from accessible roads while most of the existing roads were in difficult in transportation of inputs to and output from farms. The difficult terrain of these farms have also made movement impossible for the lending institutions and agencies, therefore depriving farmers from benefiting from loans which could be instrumental to farmers' expansion processes. This also forced some farmers to dispose their produce at give-away prices at the farm gate, which often is not profitable. The problem however ranked sixth. More often than not, a very serious problem limiting the use of *Fadama* farm lands is that of the conflicts between the *Fadama* users and the Fulani herdsmen. This findings also corroborated with the findings of Fagbemi and Abdullahi (1994), Baba and Singh (1996), Tsoho (2005) and Ndanitsa (2005). In all their studies, the authors revealed that conflicts exists between arable crop farmers and pastoralists (mostly nomads), between arable crop farmers and the foresters and/or between foresters and the nomads or even between these enterprises and the fishermen or between wealthy farmers and the poor-resource farmers.

In the study area, the farmers and nomads usually compete for *Fadama* areas. The tree-crop farmers complained that the nomads bring their livestock to the farmlands in the process. This problem which ranked third, has led to loss of

farm products worth millions of Naira, loss of farm animals and sometimes loss of human lives. Problem of land tenure and lack of proper security were also constraining the full realization of maximizing *Fadama* potentials in the study area and ranked seventh and eight respectively. **Conclusion**

The study revealed that *Fadama* tree-crop farmers in the study area had small, but scattered plots of farmland holdings mostly rented from the inhabitants of the area (as they are migrants). The study also revealed that only orange (*Citrus lemon*) enterprise should be carried out on a 0.71ha of the farmland in the study area. This is capable of yielding an optimal income of ₦78,989.48/ha/annum. In the resource combination for the optimal farm plan, capital is the most limiting resource and has a shadow price of ₦8.443. Other resources are however in surplus supply.

Therefore, to enhance the profitability and resource use through optimal farm plan tree cropping system in the study area, efforts should be geared by both the government and the non-governmental organization (NGOs) towards providing *Fadama* lands to farmers, especially tree-crop farmers on soft conditions as regards land leasing agreements. There is also an urgent need to provide extension education to *Fadama* users in the area on the benefits of *Fadama* irrigation. Funds in the form of micro-credit should be made available to these farmers at concessionary interest rates. The present tempo of using microfinance institutions (MFIs) to provide micro-credit facilities to Small and Medium-scale Enterprises (SME) should be sustained. Access roads and other infrastructural facilities should also be provided in the area. The present 'tempo' of the *Fadama* programmes in the area should also be sustained adequately. Conflicts resolution centres should be provided in the *Fadama* areas to address the incessant conflicts among the users of this critical resource.

**Table 1: Socio-economic characteristics of Fadama tree-crop farm households (N144)**

| Characteristics                     | Frequency        | Percentage        |
|-------------------------------------|------------------|-------------------|
| <b>Age in years</b>                 |                  |                   |
| 21-30                               | 15               | 12.5              |
| 31-40                               | 33               | 27.5              |
| 41-50                               | 50               | 41.7              |
| 51-60                               | 22               | 18.3              |
| <b>Gender:</b>                      |                  |                   |
| Male                                | 118              | 98.3              |
| Female                              | 2                | 1.7               |
| <b>Family Size</b>                  |                  |                   |
| 1 - 4                               | 9                | 15.8              |
| 5 - 9                               | 49               | 40.8              |
| 10 - 14                             | 27               | 22.5              |
| 15 - 19                             | 23               | 19.2              |
| 20 - 24                             | 2                | 1.7               |
| <b>Characteristics</b>              | <b>Frequency</b> | <b>Percentage</b> |
| <b>Farming Experience (Years):</b>  |                  |                   |
| 1 - 9                               | 84               | 70.0              |
| 10 - 19                             | 10               | 8.3               |
| 20 - 29                             | 11               | 9.2               |
| 30 - 39                             | 15               | 12.5              |
| <b>Level of Education attained:</b> |                  |                   |
| No formal education                 | 32               | 26.7              |
| Islamic/Qur'anic education          | 28               | 23.3              |
| Adult education                     | 6                | 5.0               |
| Primary education                   | 24               | 20.0              |
| Secondary education                 | 14               | 11.7              |
| Tertiary education                  | 16               | 13.3              |

Source: Field Survey, 2009

**Table 2: Summary of LP for tree-crop farmers**

| Variable         | Solution cost | Opportunity Coefficient | Objective Coefficient | Minimum Coefficient | Obj. | Maximum Objective |
|------------------|---------------|-------------------------|-----------------------|---------------------|------|-------------------|
| 1 X <sub>1</sub> | +0.95463824   | 0                       | + 682514.03           | + 4162.051          |      | + infinity        |
| 2 X <sub>2</sub> | 0             | +34688.392              | + 8945.68810          | - infinity          |      | + 5301            |
| 3 X <sub>3</sub> | 0             | +36318.444              | + 24556.825           | - infinity          |      | +6086             |
| 4 X <sub>4</sub> | 0             | +31806.193              | +34603.413            | - infinity          |      | +4423             |

Max. Objective = ^78.989.48k

Source: Computer printout Data Analysis, 2010

**Table 3: Resource constraints of LP for tree crop farmers**

| No. | Constraints | Status | RHS | Shadow Price | Slack surplus or | Min. RHS | Max.      |
|-----|-------------|--------|-----|--------------|------------------|----------|-----------|
| 1   | Land        | Loose  | ≤   | 0            | +0.064           | +712     | +infinity |
| 2   | Labour      | Loose  | ≤   | 0            | +94.51           | +94.714  | +infinity |
| 3   | Capital     | Tight  | ≤   | +8.453       | 0                | 0        | +1308     |
| 4   | Irrigation  | Loose  | <   | 0            | 16.45            | +88.52   | Infinity  |

Max. Objective = ^78.989.48K

Source: Field Survey, 2010

**Table 4: Ranking of Constraints to Fadama Tree Crop Production**

| Problem                       | Rank |
|-------------------------------|------|
| Pest and disease infestation  | 1    |
| Land tenure problem           | 7    |
| Inadequate labour supply      | 5    |
| Inadequate among Fadama users | 3    |
| Problem of flooding           | 4    |
| Non-accessible road           | 6    |
| Lack of proper security       | 8    |
| Inadequate fund               | 2    |

Source: Field survey, 2009

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measures, indicating that a unit increase in those variables will ensure constant practice of the safety measures by the respondents.

**Table 7**  
**Correlation between socio-economic characteristics of the respondents and practice of safety measures**

| Description of variables             | Practice of safety measures |
|--------------------------------------|-----------------------------|
| Age (years)                          | -0.290*                     |
| Marital status (dummy)               | 0.183 <sup>NS</sup>         |
| Education ( years)                   | 0.461*                      |
| Farming experience (years)           | 0.337*                      |
| Farm income (naira)                  | 0.307*                      |
| Farm size (hectare)                  | 0.190 <sup>NS</sup>         |
| Practice of safety measures (number) | 1.00                        |

Source Computed from field survey, 2012

\*correlation is significant at 0.05 levels

r-values at 0.05=0.232

NS= Not significant

### Conclusion

Most of the respondents were in need of training on application and handling of agro-chemicals. Education, farming experience and farm income had positive correlation with practice of safety measures by the respondents.

### Recommendations

Extension awareness campaign should be carried out in the state to raise the level of awareness on the safety measures of agro-chemicals and for farmers to take the safety measures very serious.

List of reputable agro-chemical dealers in the state should be compiled by extension agent and made known to the farmers for patronage.

Lighter protective clothing and rubber boots should be designed by their manufacturers for farmers' conveniences, while the character of the instruction labels on the containers of agro-chemicals should be boldly written for ease of reading.

To build farmers' capacity for safe use and application of agro-chemicals in the state, extension education should pay particular attention to training the farmers on agro-chemical safety issues such as application, handling and disposal of waste/containers of agro-chemicals. This is necessary to prevent both human and animal health hazards as well as environmental hazards.

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