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# Farm Planning Model for Sustainable Vegetable Crop Production in the Eastern Part of Kogi State, Nigeria

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**Abstract:** The study examined the farm planning model for sustainable vegetable crop production in the Eastern part of Kogi State, Nigeria. Specific objectives of the study were to: identify the various cultural practice, irrigation sources and application methods and also to determine the net benefits of the farmers with respect to vegetable crop production. Multi-stage random sampling technique was used. From the study area, three local government areas were randomly selected. In each local government area, two villages each where there is extensive irrigation cultivation were purposively selected making a total of 6 villages. Samples of twenty farmers from each of the 6 villages were selected giving a total sample of 120 farmers in all. Data were collected with the assistance of trained enumerators using structured questionnaire, interview and on-the-farm observation. Farm budget planning model was used to determine the net benefits of the vegetable crop production by the farmers. The result reveals that gross total variable cost was N23, 378.59 and gross total fixed cost was 603.80 representing 97.48 and 2.52% of the gross total cost of N23, 982.39, respectively. Cost of fertilizer and fuel constitutes 30.62 and 38.38%, respectively of the gross total variable cost. The gross returns was N447,136.00 having the highest contribution margins of 51.47 and 27.86% from onion and pepper, respectively. The results of the profitability index revealed that RRI was 1,764.43%; RRFC was 70,181.75%; RRVC was 1,910.00% and CTO was 18.64. The result of RRI which is above 100% signifies that the 120 sample farmers do not require additional capital for crop production. The RRVC and RRFC were also above 100% meaning that some of the vegetable crop production inputs are high and as such needed to be subsidized in order to increase CTO of the sample farmers. The CTO has a value of 18.64 implying that for every additional Naira spent by the sampled farmers on inputs will yield about N18.64 net returns. The study recommend the need for the Government to subsidize some of the farm inputs based on the results of RRVC and RRFC which were above 100% revealing that some of the vegetable crop production inputs are high.

**Key words:** Farm planning, sustainability, net farm income, Kogi State

## INTRODUCTION

Agriculture is becoming a more complex enterprise and as such, farmers whether progressive or backward, literate or illiterate, plan their farm business at the beginning of every crop season so as to determine what crops and livestock enterprises to produce, what amount of resources to commit, how the various operations is to be organized, what amount of credit to borrow etc. Farm planning precedes all other management functions. It involves setting the farm objectives and line of action to be followed in deciding in advance the farm production management problems viz, what to produce, how to produce and when to produce as well as financial management problems viz, how to borrow, how much to borrow, when to borrow, where to borrow and marketing management problems viz, where to buy and sell, when to buy and sell, how to buy and sell etc. Farm planning model bridges the gap from where we are to where we want to be in competitive and dynamic environments.

Nigeria has been so densely populated today with a population of about 150 million people to the extent that even though birth rates are decreasing, it is assumed that 1 to 1.5 million will be added to the number yearly. Increasing productivity gains have, in general, decreased food costs and improved food security, particularly for vulnerable sections of the society. Further to this is the introduction of improved or short-duration varieties which has contributed to higher food production and improved the returns to costly resources used by poor farmers, while crop- and resource-management technologies have improved environmental and resource sustainability.

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Cultivation of less-favourable lands made possible by new plant varieties (for example, wet and dry season irrigated farms, drought-tolerant crop varieties etc.) has also contributed to higher food production.

Ramaswamy and Sanders (1992) observed that increasing population pressure in the semi arid regions of the Sahel has resulted in the breakdown of the fallow system and reduced availability of communal land. They emphasized that adoption of sustainable yield increasing technologies is critical to the future development of the region. A farm level planning model was constructed for Central (Mossi) Plateau of Burkina Faso. Farmers were induced into adopting yield increasing intensive technologies as land supply becomes more inelastic and as the economic environment becomes more profitable.

Water Research Commission (2005) explained that the main pathways for enhancing Water Use Efficiency (WUE) in irrigated agriculture are to increase the output per unit water, reduce losses of water and reduce water degradation. Possible ways of achieving more efficient use of available water supplies for irrigation include coordinated approach at different levels of the water system and irrigation management sub-systems. This is the scheme level sub-system, which includes the segment from the water source to the farm boundary, the farm and field sub-systems which extend from the farm edge to the root zone.

Sani *et al.* (2007) revealed that since areas under vegetable cultivation has increased; there is the need to develop new modern processing plants technologies to take care of the surpluses arising out of vegetable crop production in view of the fact that crop cultivation has become a way of life of the cultivars. The author further recommended that the government should play supportive roles of creating enabling environment in order to achieve sustainability of farm activities since the average size of family and effective workers per farmindicated a consistently increasing trend due to joint family labour.

Fairweather *et al.* (2003) further emphasized that at the scheme level sub-system, conveyance efficiency is the responsibility of the Catchment Management Agencies (CMAs), Water User Associations (WUAs) and Department of Water Affairs and Forestry (DWAF). Farm efficiency (or the volume of water delivered to the field edge divided by the volume delivered to the farm) and field efficiency (defined as the volume of irrigation water that replenishes the rooting zone as a function of water supplied to the field) are the responsibility of the farmer. In an ongoing research project, standards and guidelines are being developed for improved efficiency of irrigation water use from dam-wall release to root zone application.

Oyaide (1989) emphasized that agricultural extension services in Nigeria have proved to be particularly helpful and successful in the introduction of new farming methods, new farming technologies, produce preservation methods, processing methods and marketing outlets. The Agricultural Development Project (ADP) at the State level has devised many effective techniques to reach and educate the rural farmers so as to maintain the tempo of sustainable agricultural development.

Kushwaha and Gupta (1989) revealed that as a result of specialized farming due to greater use of external inputs insects are becoming resistant to insecticides and require higher rates of application or new insecticides for control. New insects sometimes replace the old. Beneficial insects often are destroyed along with the pests requiring even greater reliance on insecticides at higher costs. The same type of problems are appearing for herbicides as new, more resistant weeds appear after others are brought under control. In addition, herbicides carry over and build up in some soils can equally cause problems.

Abrol and Katyal (1990) emphasized that soil fertility research in future should address to soil-plant-animal system as a unit. Fertilizers continue to play a vital role in our efforts to maintain farm productivity. They emphasized on minimization of loss to increase efficiency of fertilizer use. Computer simulation models with the capability of readily simulating environmental variables and various crop management strategies should lead to significant improvement in efficiency of fertilizer use on wide ranging agro-ecological situations.

Ogunfowora (1970) examined the problem of optimum farm plans in Western Nigeria using linear programming. This analysis sought to provide answers to the problem of planning an efficient farm organization which could achieve the dual objective of providing an adequate income for the settler and his family and be self financing within a short period. The 3 year period analysis shows that this can be attained with a reasonable level of income under an optimal combination of enterprises at the current level of technology.

Kushwaha *et al.* (1999) reported that farming essentially, is a bio-economic activity where the farmer manages certain resources to produce feed and fibre. The decisions farmers make and plan are complex with regards to farm objectives of producing for subsistence and increasingly for cash calling for subsidiary objectives that may be achieved in varying degree. Even though farm objectives do conflicts, the farmer has four production objectives ranging from satisfying family food requirements to minimization of economic risk. It was further revealed that farmer's ranking of production objectives for dry and rainy season is not the same and as such production objectives ranking depends on seasonal factor.

Vedula and Rogers (1981) developed a mathematical planning model to find optimum cropping pattern in irrigation in the context of river basin development. The monthly deterministic model was applied to a four reservoir systems in southern India to maximize the net economic benefits and the irrigated cropped area subject to water, land and downstream release constraints. The objectives of maximizing net benefits and irrigated area are found to conflict with each other. The transformation earns between the two objectives was developed and the trade-off was estimated at the level of irrigation development proposed by the planning agency.

Marangon (1992) mentioned that the relation between agriculture and environment can be studied by referring to the micro-economic implications arising from the demands of society for environmentally friendly agricultural production. Among the different approaches which can be used, special attention has been paid to the recent methodologies developed by multiple criteria decision making. The effects on farm management resulting from multiple conflicting objectives (private and social) have been estimated. The multi-objective optimization leads to the determination of a trade-off among different objectives. It is then possible to evaluate the compensation required by the farmers (profit maximization) in terms of improvement in the attainment of ecological objectives (minimization of chemical inputs).

In a study conducted by Sani (2000), it was mentioned that the areas under less remunerative and low labour demanding vegetable crops has declined and shifted to higher remunerative and more labour intensive crops keeping in view the carrying capacity of land and water in a sustainable manner and also considering application of low input and sustainable farming system based on the available farm resources. This call for concerted government policy in order to enhance agricultural productivity and food security, resource use efficiency and investment and conserving natural resources without affecting the environment and the ecosystem.

## MATERIALS AND METHODS

**The study area:** The study was carried out in Kogi State of Nigeria. The State which was created out of Benue and Kwara States of Nigeria on the August 27, 1991 is located at the confluence of the River Niger and the River Benue and it occupies 29,833 square kilometers, 2,774,700 hectares, 6,825,762 acres and covers 10,838.67 square miles, 709,000 farming families and a total population of 3,278,487 people (NPC, 2006; NBS, 2008). The study area is also characterized by both wet and dry season with annual rainfall ranging between 800 to 1100 mm and beginning from April to September (6 months) leaving a dry season period of about 6 months within which the sampled farmers carry out their irrigation farming.

**Sampling procedure:** Multi-stage random sampling technique was used. From the study area, three local government areas were randomly selected. In each local government area, two villages each where there is extensive irrigation cultivation were purposively selected making a total of 6 villages. A preliminary study was carried out to determine the irrigation small holder farmers in vegetable cultivation. The villages are: Okoliko-ojeta and Olondu in Bassa local government area; Adoji and Okura in Dekina local government area and Onyedega and Odeke in Ibaji local government area. Samples of twenty farmers from each of the 6 villages were selected giving a total sample of 120 farmers in all. Research data were collected with the assistance of trained enumerators using structured questionnaire, interview and on-the-farm observation.

**Model specification:** In order to identify and formulate sustainable planning model for small - scale agriculture in the eastern part of Kogi State of Nigeria, it is essential to incorporate such activities which are acceptable to the sampled farmers. Activities sets include all the economic activities or techniques being followed as a means of realizing the farming objectives.

The farm budget planning model for realizing sustainable vegetable crop production in the eastern part of Kogi State, Nigeria is specified as follows:

$$NFI = TGI-FC-VC$$

Where:
NFI = Net farm income (Naira)
TGI = Total gross income (Naira)
FC = Fixed cost (Naira)
VC = Variable cost (Naira)

All the major crops grown by the farmers are: onions, tomato, pepper, okra and water leaf. The livestock activities of the study farmers include: cattle, goat, duck, sheep and chicken.

## RESULTS AND DISCUSSION

Table 1 which shows the results of cultural practices adopted by farmers in the study revealed that due to the adoption of more intensive farming and improvement in the knowledge of farmers, the number of ploughing in

respect of onion, tomato and pepper was reduced to half. Broadcasting of seeds, sowing behind plough and transplanting were the main sowing methods. Manual weeding was the only major method of weed management. These changes were examined on the basis of farmer's knowledge and experienced. This result is in consonance with Alao (1980) who confirmed that the states of knowledge of institutional aspects relating to improved farming systems of variety crops and contact with extension workers are significant factors influencing adoption of modern agricultural practices.

Table 2 indicates the results of per capita availability of cultivable land, irrigated area on the sample farmers. It revealed a decreasing trend in the per capita availability of land on all farms. The table further reveals that more than 80% of the sampled farmers have assured irrigation facilities.

Table 3 revealed that the major irrigation sources are rivers and stream, tube well and wash bore and at times residual moisture. The major delivery methods are pump and manual. This finding is in consonance with Kushwaha and Sani (1998) where it was reported that farmers in their farm planning process tends to adopt new agricultural inputs for crops that are of higher yields and less in conflict with their respective farm objectives.

Table 4 shows that farmers maintain livestock and birds as supplementation to crop failures and also for purpose of animal traction. The result further revealed that the farmers could not adopt the technology of animal traction due to high rate of capital investment to purchase oxen and tracking implements.

Table 5 signifies the socio-economic characteristics of the farmers. The result reveals that most farmers are within the age 31-40 years (50%); mostly illiterate, primary drop out and some trying to attain adult education due to poverty and high cost of education. Most of the farmers 51% inherited the cultivated land; effective workers per farm are high in Bassa L.G.A (50%), Dekina L.G.A 16.7% and Ibaji L.G.A (33.3%).

Table 6 revealed the cropping pattern of the farmers during the cropping season. The result indicated that the major crops grown on the three categories of farms include onion, tomato and pepper. Crops like okra and water leaf are not popularly grown on all farms implying a rapid change in cropping pattern in favour of the major crops and which result in declining soil fertility. The gross cropped area are 0.76, 2.11 and 1.22 ha representing net cropped area of 0.42, 0.39 and 0.64 ha in Bassa L.G.A, Dekina L.G.A and Ibaji L.G.A, respectively. Singh *et al.* (1993) confirmed this result when it was stated that cropping pattern changes rapidly as a result of high level of technological adoption.

Table 7 shows gross farm budget (cost and returns) of the study farmers. The result reveals that gross total variable cost was N23, 378.59 and gross total fixed cost was 603.80 representing 97.48 and 2.52% of the gross total cost of N23,982.39, respectively. Cost of fertilizer and fuel constitutes 30.62 and 38.38%, respectively of the gross total variable cost. The gross return was N447,136.00 having the highest contribution margins of 51.47 and 27.86% from onion and pepper, respectively.

The results of the profitability index revealed that rate of returns on investment (RRI) was 1,764.43%; rate of returns on fixed cost (RRFC) was 70,181.75%; rates of returns on variable cost (RRVC) was 1,910.00% and Capital

Table 1: Cultural practices of irrigated farmers in the study area

| Particulars | Unit/methods |
|---|---|
| Ploughing | |
| Onions | 1-2 |
| Tomato | 1-2 |
| Pepper | 2-3 |
| Okra | 2-3 |
| Water leaf | 2-3 |
| Sowing | |
| Onions | Behind plough |
| Tomato | Broadcasting/transplanting |
| Pepper | Broadcasting/transplanting |
| Okra | Behind plough |
| Water leaf | Broadcasting/transplanting |
| Method of irrigation | Pumpset/tubewell/dipwell/flooding |
| Crop rotation: | Crop rotation with legumes and monoculture |
| Weed management | Manual weeding |
| Harvesting | Manual. |

Source: Field Survey Report, 2009

Table 2: Average size of holding, irrigated area and per capita operated area of the sample farmers

| | | | | Per capita availability of land | |
|---|---|---|---|---|---|
| Category | Average size of holding | Net cropped area | Irrigated area per farm | Family member | Effective farm worker |
| Bassa L.G.A | 0.55 | 0.42 | 0.39 (92) | 0.1110 | 3 |
| Dekina L.G.A | 0.62 | 0.39 | 0.33 (84) | 0.2101 | 10 |
| Ibaji L.G.A | 0.91 | 0.64 | 0.59 (92) | 0.3110 | 2 |

Values in parentheses is showing percentage to the Net cropped area

Table 3: Distribution of sample farmers according to irrigation sources and application

| Details | Bassa L.G.A | Dekina L.G.A | Ibaji L.G.A | Total |
|---|---|---|---|---|
| **Irrigation source:** | | | | |
| Open well | 1 | 0 | 2 | 3 |
| Pond/Reservoir | 8 | 0 | 8 | 16 |
| River/stream | 20 | 26 | 22 | 68 |
| Tubewell/washbore | 8 | 13 | 3 | 24 |
| Residual moisture | 3 | 1 | 5 | 9 |
| Total: | 9 | 40 | 40 | 120 |
| **Application method:** | | | | |
| Pump | 34 | 28 | 11 | 73 |
| Manual | 6 | 9 | 21 | 36 |
| Shadoff | 0 | 3 | 2 | 5 |
| Residual moisture | 0 | 0 | 6 | 6 |
| Total: | 40 | 40 | 40 | 120 |

Source: Field Survey Report, 2009

Table 4: Status of livestock and birds on the sampled farmers

| | Bassa L.G.A | | Dekina L.G.A | | Ibaji L.G.A | | Total | |
|---|---|---|---|---|---|---|---|---|
| Details | No. of farmers | No. of livestock | No. of farmers | No. of livestock | No. of farmers | No. of livestock | No. of farmers | No. of livestock |
| Bullock | 0 | 0 | 0 | 0 | 1 | 1 | 4 | 5 |
| Cow | 4 | 6 | 4 | 10 | 8 | 2 | 16 | 18 |
| Goats | 6 | 22 | 3 | 48 | 18 | 29 | 27 | 99 |
| Sheep | 12 | 60 | 6 | 18 | 48 | 200 | 66 | 278 |
| ducks | 18 | 180 | 11 | 79 | 13 | 60 | 42 | 272 |

Source: Field Survey Report, 2009

Table 5: Socio-economic characteristics of the sample farmers

| Details | Bassa L.G.A | Dekina L.G.A | Ibaji L.G.A | Total |
|---|---|---|---|---|
| Age and sex: | | | | |
| <30 years | 2 (05) | 5 (12.5) | 13 (32.5) | 20 |
| 31-40 years | 22 (55) | 9 (22.5) | 19 (47.5) | 50 |
| 41-50 years | 5 (12.5) | 16 (40) | 6 (15) | 27 |
| 51-60 years | 10 (25) | 7 (17.5) | 1 (2.5) | 18 |
| 61> years | 1 (2.5) | 3 (7.5) | 1 (2.5) | 5 |
| Average size of family | 14 (50) | 8 (28) | 6 (22) | 28 |
| Educational level | | | | |
| Illiterate | 19 (47.5) | 6 (15) | 2 (05) | 27 |
| Primary | 7 (17.5) | 3 (7.5) | 22 (55) | 32 |
| Secondary | 1 (2.5) | 1 (2.5) | 7 (17.5) | 9 |
| Post Secondary | 2 (05) | 2 (05) | 3 (7.5) | 7 |
| Arabic | 5 (12.5) | 4 (10) | 4 (10) | 13 |
| Adult Education | 6 (15) | 24 (60) | 2 (05) | 32 |
| Ownership pattern | | | | |
| Gift | 0 (0) | 1 (2.5) | 4 (10) | 5 |
| Rented | 4 (10) | 5 (12.5) | 22 (55) | 31 |
| Purchased | 2 (5) | 21 (52.5) | 10 (25) | 33 |
| Inherited | 34 (85) | 13 (32.5) | 4 (10) | 51 |
| Effective workers per farm | 3 (50) | 1 (16.7) | 2 (33.3) | 6 |

Values in parentheses are showing percentage to the total of each parameter

Table 6: Cropping pattern of the sample farmers in Dry Season (DS)

| Crops | Bassa L.G.A | Dekina L.G.A | Ibaji L.G.A |
|---|---|---|---|
| Onions | 0.03 (0.07) | 0.04 (0.10) | 0.11 (0.17) |
| Tomato | 0.08 (0.19) | 0.16 (0.41) | 0.19 (0.29) |
| Pepper | 0.10 (0.23) | 0.13 (0.33) | 0.14 (0.21) |
| Okra | 0.19 (0.45) | 0.01 (0.02) | 0.08 (0.12) |
| Water leaf | 0.02 (0.04) | 0.05 (0.12) | 0.12 (0.18) |
| Gross cropped area | 0.76 (180) | 2.11 (541) | 1.22 (190) |
| Net cropped area | 0.42 (100) | 0.39 (100) | 0.64 (100) |

Values in parentheses are showing percentage to the net cropped area

Table 7: Gross farm budget (cost and returns) of the sample farmers

| Cost (Naira) | Returns (Naira) |
|---|---|
| Variable Cost (VC: Naira): | Sales: |
| Hired labour 1,867.00 | Onions 230,144.50 |
| Fertilizer 7,159.00 | Tomato 42,889.00 |
| Pesticides 3,280 | Pepper 124,555.60 |
| Pump hire 420.00 | Okra 14,225.00 |
| Fuel (petrol) 8,971.59 | Water leaf 6,156.90 |
| Seedling 1,681 | Crop residues 2,150.00 |
| Total VC: 23,378.59 | Livestock sales 15,400.00 |
| Fixed cost (Naira): | Value of farm produce |
| Tears and wears on pump/tube well 111.50 | consumed at home 11,615.00 |
| Tears and wears on shadoff structures 492.30 | Total Returns: 447,136.00 |
| Total fixed cost: 603.80 | |
| Total cst (Naira): 23,982.39 | |
| Net Farm Income (NFI): 423,153.61 | |

Turnover (CTO) was 18.64. The result of RRI which is above 100% signifies that the 120 sampled farmers do not require additional capital for crop production. The RRVC and RRFC were also above 100% meaning that some of the vegetable crop production inputs are high and as such needed to be subsidized in order to increase CTO of the sample farmers. The CTO has a value of 18.64 implying that for every additional Naira spent by the sample farmers on inputs will yield about N18.64 net returns.

These rates are calculated as:

$$\text{Net Farm Income} = \text{Total gross returns-Total cost (TVC+TFC)}$$
$$= 447,136.00\text{-}23,982.39$$
$$= 423,153.61$$

$$\text{Rate of returns on investment} = \frac{\text{Net farm income}}{\text{Total cost}} \times 100$$
$$= \frac{423,153.61}{23,982.39} \times 100\%$$
$$= 1,764.43\%$$

$$\text{Rate of returns on fixed cost} = \frac{\text{Total returns-TVC}}{\text{TFC}} \times 100$$
$$= \frac{447,136.00\text{-}23,378.59}{603.80} \times 100\%$$
$$= 70,181.75\%$$

$$\text{Rate of returns on variable cost} = \frac{\text{Total Returns-TFC}}{\text{TVC}} \times 100$$
$$= \frac{447,136.00\text{-}603.80}{23,378.59} \times 100\%$$
$$= 1,910.00\%$$

$$\text{Capital turnover} = \frac{\text{Total returns}}{\text{Total cost}}$$
$$= \frac{447,136.00}{23,982.39}$$
$$= 18.64$$

## CONCLUSION AND POLICY IMPLICATIONS

From the results of cost and returns analysis, the vegetable crop production activities of the sampled farmers in the Eastern part of Kogi State, Nigeria is economically viable and sustainable based on the applied farm planning model. The gross net farm income is high and sustainable. The government need to subsidize some of the farm inputs based on the results of RRVC and RRFC which were above 100% revealing that some of the vegetable crop production inputs are high.

## REFERENCES


Abrol, J.P. and J.C. Katyal, 1990. Managing soil fertility for sustained agriculture. Proc. Int. Symp. Nat. Resour. Manage. Sustainable Agric., 2: 235-263.

Alao, J.A., 1980. Understanding Small Farmers Adoption Behaviour: The Nigerian Experience. Inaugural Lecture Series 44. University of Ife Press, Ile-Ife. Nigeria.

Fairweather, H., N. Austin and M. Hope, 2003. Water Use Efficiency: An Information Package. Irrigation Insights No. 5. Land and Water, Canberra, Australia.

Kushwaha, S. and M.H. Sani, 1998. Socio-economic analysis of adoption efficiency: A case study of dass LGA of Bauchi State, Nigeria. Kano. J. Arts Social Sci., 1: 1-5.

Kushwaha, S. and S.B.L. Gupta, 1989. Resource allocation for alternative farming system. J. Rural Integration, 8: 8-15.

Kushwaha, S., B.M. Hamidu, S.T. Mbap and S.M. Hussaini, 1999. Revealing the hierarchy of farmers' production objectives: The need for application of management planning model to farming. Proceedings of FAMAN, Bauchi, Sept. 20-23, Bauchi, Nigeria, pp: 232-234.

Marangon, F., 1992. Low input agriculture and agricultural economics: A multi-objective approach. Rivista Economia Agraria, 47: 545-593.

NBS., 2008. Annual Abstracts of Statistics of Nigeria. National Bureau of Statistics, Nigeria.

NPC., 2006. Year Book on Nigeria Population Data. Natioal Population Commission, Nigeria.

Ogunfowora, O., 1970. A linear programming analysis of income opportunities and optimal farm plans in peasant farming. Bull. Rural Econ. Soc., 5: 223-250.

Oyaide, O.F.J., 1989. The challenges of rural development in Nigeria. Federal Agric. Dev. Unit Occasional Paper, 7: 15-27.

Ramaswamy, S. and J.H. Sanders, 1992. Population pressure, land degradation and sustainable agricultural technologies in Sahel. Agric. Syst., 40: 361-378.

Sani, M.H., 2000. Sustainable strategy for vegetable farming under small-scale fadama condition: A case study of dass LGA of Bauchi State, Nigeria. Ph.D. Thesis, Abubakar Tafawa Balewa University, Bauchi.

Sani, M.H., S. Kushwaha, M.M. Abubakar and G.B. Ayoola, 2007. Economics of sustainable vegetable farming under fadama conditions in dass local government area, Bauchi State. Econ. Aff., 50: 46-51.

Singh, J., I.S. Chatha and D.K. Grover, 1993. Sustainability of agriculture in punjab: Some ecological considerations. Indian J. Agric. Econ., 48: 597-597.

Vedula, S. and P.P. Rogers, 1981. Multi-objective analysis of irrigation planning in river basin development. Water Resour. Res., 17: 1304-1310.

Water Research Commission, 2005. Water-Efficient Production Methods in Relation to Soils, Crops and Technology in Rain-Fed and Irrigated Agriculture. Institute for Agricultural Engineering, Knowledge Review, Pretoria, South Africa.