



# **NIGERIAN JOURNAL OF ECONOMICS AND DEVELOPMENT MATTERS**



An International Journal for the Promotion of Research in  
Socio-Economic, Management and Development Issues.

VOLUME 2

DECEMBER 2003

NUMBER 1

NJEDEM

ISSN 1596 - 7204

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# ALLOCATIVE EFFICIENCY IN WETLANDS (FADAMA) FARMING: THE CASE OF SOUTH-EASTERN NIGERIA INLAND VALLEYS

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## ABSTRACT

*This study analyzes allocative efficiency of a sample of inland valleys farmers in Akwa Ibom State, South-Eastern, Nigeria. The results indicate that labour – both family and hired, plays an important role in farm profit. Family labour accounts for 48.43% and 41.54% of the operational costs in the cassava/fluted pumpkin/okro and cassava, cocoyam/maize/fluted pumpkin crop mixtures. Farmers were found to be efficient in the use of fertilizer, planting materials and investment on durable items but inefficient in the use of family and hired labour.*

**Keywords: Efficiency, wetlands, inland valleys, Nigeria.**

## 1. INTRODUCTION

The issue of food self-sufficiency has been the concern of successive Nigerian administrations. However, the attainment of food self-sufficiency depends, to a large extent, on the efficient use of available resources. One of the agricultural resources available to Nigeria is wetlands (*fadama*). Wetlands are considered as areas of marsh, fern, peatlands or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt water the depth of which at low tide does not exceed six metres. Ecologically, they are transitional between open water and terrestrial ecosystems and endowed with specific structural and functional attributes performing major ecological roles in the biosphere (Edwards, 1986). Within Africa, wetlands embrace river flood plains of various sizes and kinds (including *fadama* – Hausa name for land which is flooded in the wet season) marshes, lakes and coastal deltas and brackish and marine environments including mangroves (Burgis and Synoes, 1987). The wetlands in Nigeria, though scattered and in pockets, cover over 24,009km<sup>2</sup>.

The Nigerian wetlands are of great importance to many people, especially, those who live along the coastlands. They are utilized in industrial, agricultural, fishery, wildlife, tourism and recreation endeavours. Official attempt to develop wetlands for farming purposes in Nigeria started in 1933 with the cultivation of rice in Calabar, Oron, Warri, Mbiakpakpa, Oloibiti and Oloibiri. Ever since, efforts in this direction has continued with the establishment of the River Basin Development Authorities and the currently implemented National Fadama Development Programme.

Notwithstanding the contribution and potential contributions of wetlands to the nation's agricultural future, empirical research in this direction has been few and far between. At best, attention has been focused on its conservation as a biological resource. Most analysts assumed that wetlands are a public good, consequently research has focused on trying to assign economic values as part of the process of developing and evaluating preservation policies (Doss and Taff, 1996). Studies conducted on the agricultural aspects of wetlands, have been concerned with a single enterprise, particularly rice (Osifo, 1971; Olagoke, 1991). But a single enterprise approach cannot

be viewed as realistic framework to farm business analysis. A single crop does not give a good indication of the income position of the whole farm with various crops. It does not highlight the trade-off situations or enterprise combination problems faced by the farmers (Djougenou, 1981). The wetlands farmer, like any other farmer, should be interested in how to allocate available resources to different enterprises rather than single enterprise. This assumption is supported by various reports (Agboola, 1987, Gwarry, 1995) that crop enterprises of varying combinations are cultivated on the wetlands.

The main aim of wetlands farming is to increase food supply by cultivating more land and carrying out productions of crops throughout the year. This is very necessary for national food security. Recent thinking about wetlands management is built around the concept of "wise use" which places emphasis on the economic values and uses of wetlands (Adams and Stockwell, 1983, Constanza *et al.*, 1989)

The theory of production economics at which centre is the concept of efficiency is in line with the wise use practices. It also needs bold and innovative decision-making about the planning and management of the resources. The study that culminated in this paper was designed to evaluate the efficiency with which wetlands farmers allocate their resources in crop production activities. Specially, attempt was made to examine the cost and returns associated with wetlands farming; determine the impacts of the farm resources on the profit level and estimate the resource use efficiency in wetlands farming.

## 2. CONCEPTUAL UNDERPINNINGS

The basic thrust of the agricultural production at the microlevel is to assist individual farmer or groups of farmers attain stated objectives through efficient intra-farm allocation of resources during a period or over a period of time. Economics of agricultural production is achieved either by maximizing output from a given set of resources or minimizing the resources required for producing a given output. Literature identify different types of efficiency measures, of which allocative or price efficiency is one. Allocative efficiency relates to choosing an optimal set of inputs. It refers to the appropriate choice of input combinations. A farm is allocatively efficient if production inputs are allocated according to their relative prices. Consequently, price or allocative inefficiency results from suboptimal input combinations.

The equi-marginal principles of equal marginal returns is the neoclassical economic criterion of efficiency in resource use and allocation in multiproduct firms such as wetland farms. For a multiproduct firm to be said to have allocated its resources optimally among its feasible production enterprises, it must do it in such a way that the marginal value product (MVP) of every input is equal in all enterprises in which it is employed and also equal to the price of the input (Upton, 1973). This can be presented mathematically as:

Given the production function  $Y_j = f(x_j)$  ..... (1)

$MVP_{ij} = MVP_{12} \dots MVP_{nm} \leq P_j$  and all  $i(i=1 \dots n, j=1 \dots m)$  .....(2)

$MVP_{ij}$  is the marginal value product of the input (X) used in the production of the jth product (Y) and  $P_i$  is the unit price of the input i. Most literature on allocative efficiency in agriculture test efficiency by determining whether the marginal value product is equal to the input price. By such a measure, most studies have found peasant farmers to be reasonably efficient. Dillon and Aderson (1971) in an article generally critical of the

methodology employed in this area concluded that using a probabilistic technique does not change this conclusion. According to Akinwumi (1970), so long as the pricing system accurately reflects the value system of consumer choice the value productivity of resource can serve as an index of production efficiency. In this study, the ratio of marginal value products of inputs to their prices was employed as a measure of allocative efficiency in wetland farming.

### **3. RESEARCH METHODS**

**The Study Area:** The research was conducted in Akwa Ibom State (latitude  $4^{\circ} 32'$  North and longitudes  $7^{\circ} 25'$  and  $8^{\circ} 25'$  East), Nigeria. It occupies a distinct and contiguous area of 7,024.008 square kilometers with a population of 2.53 million (NPC, 1991). It is situated in the South Eastern corner of Nigeria.

The state has three ecological zones which are the marshy land of the river washed areas of Eket, Ibeno, Ikot Abasi, Oron and Itu Local Government Areas, the flat areas of Etinan, Abak, Uyo and Ikot Ekpene Local Government Areas and the elevated areas of Ikono and parts of Itu Local Government Areas. The state is endowed with abundant wetlands which are exploited for agricultural purposes. The wetlands make up 31.6 percent of its total land area. The entire periphery of the state would have been swamps were it not for part of the western boundary between Imo river and Enyong Creek which is dry land in most parts. The swamp forms a continuum but have however, been broken down into discrete units and named after important settlements.

#### **3.1 Data Sources and Sampling Procedures**

To obtain the relevant primary farm household data used in the study, farm management survey was conducted using structured questionnaire. The primary data so collected were supplemented with secondary data from Akwa Ibom State Agricultural Development Project (AKADEP), Federal Office of Statics and the Central Bank of Nigeria Annual Report and Statement of Accounts (Various issues).

Multistage sampling technique was employed in selecting the sample needed for the study. First, wetland locations were selected based on information on their importance in wetlands farming. Three types of wetlands – inland valleys, flood plains, and mangrove swamps were identified. The concern in this study was the inland valleys. The second stage of sampling was the selection of villages.

Information on the population of the villages and their importance in wetland farming were obtained from the State's Ministry of Agriculture and AKADEP. The last stage of sampling was the random selection of 150 wetland (inland valleys) farming households from the list provided by the Ministry and AKADEP.

#### **3.2 Analytical Techniques**

The farm management data collected from farm households were analysed using budgeting approach and normalized profit function.

**3.2.1 Budgeting Approach:** This was used to assess the profitability of the various crop/crop combinations by farmers. The gross margin derived from the production was computed as:

$$GM = \sum P_i Y_i - C_i \quad (i = 1, 2, \dots, n) \dots\dots\dots(3)$$

Where GM. = gross margin from crop/crop mixtures  
 $P_i$  = market price of the  $i$ th crop (₦/unit) in the enterprise (crop or crop mix)  
 $Y_i$  = annual yield of the  $i$ th crop (grains equivalent in kg/ha)  
 $C_i$  = imputed cost (variable) in producing the  $i$ th crop (₦/ha).

**3.2.2 The Normalized Profit Function:** The impacts of resources on farm profit level were determined using the normalized profit function. This has been used by a number of researchers in agricultural production analysis (Lau and Yotopolous 1972; Kalirajan,1981; Dittoh,1991). Estimates obtained from the profit function are known to be more consistent than the parameters derived from the production function, because it assumes all inputs to be exogenously determined. Also, the supply and demand function can be easily derived where there was the need for such.

Given the production function of the form

$$Q = f(x, z) \dots\dots\dots(4)$$

Where  $Q$  = total quantity of output,  $X$  = vector of quantities of variables input of production,  $Z$  = vector of quantities of fixed inputs, the first order conditions for maximization of profit with respect to the variable inputs are:

$$\frac{\partial Q}{\partial x_j} = r_j; \quad (j = 1, 2, \dots, m) \dots\dots\dots(5)$$

where,  $r_j$  is the price of the  $j$ th variable input;

The demand for the  $i$ th variable input of the profit maximizing farm can be computed from equation (5). Thus, we

$$X_j = f_j(r, z), \quad (j = 1, 2, \dots, m) \dots\dots\dots(6)$$

Where  $X_j$  denotes the optimal quantity of the  $j$ th input and  $r$  is the vector of normalized prices of the variable input.

Profit function can be given as:

$$\Pi = P(Q) - \sum_{j=1}^m r_j x_j \dots\dots\dots(7)$$

where,  $\Pi$  is profit,  $P$  is the price of output, other notations remain as earlier defined. Substituting equations (4) and (6) into equation (7) permits the expression of profit as a function of the normalized prices of the variable inputs and the quantities of the fixed inputs.

$$\Pi = P [F(f_j(r, Z), \dots, F_m(r, Z) - \sum_{j=1}^m r_j f_j(r, z)] \dots\dots\dots(8)$$

Normalized restricted profits,  $\Pi^*$  are thus given by

$$\Pi = A^* \sum_{j=1}^m a_j^* \sum_{j=1}^n z_j^{B^*} \dots\dots\dots(10)$$

where  $A^*$ ,  $a_j^*$  and  $B^*$  are parameters to be estimated. Expanding and linearizing equation (10) gives.

$$\ln \Pi = \ln A^* + a^*_1 \ln q_{fl} + a^*_2 \ln q_{hl} + a^*_3 \ln q_f + B^*_4 \ln Z_s + B^*_5 \ln Z_i \dots \dots \dots (11)$$

Where A\*, a\* and B\* are as defined earlier and  $\Pi$  = normalized profit, qfl = normalized price of family labour, qhl = normalized price of hired labour, qf = normalized price of fertilizer, Z<sub>s</sub> = normalized price of planting materials, Z<sub>i</sub> = capital investment on durable items, Ln = natural log. *A priori*, the coefficients of the inputs (the parameters) are expected to be positively signed.

#### 4. RESULTS AND DISCUSSION

##### 4.1 Cost and Returns

Since different crop or crop combinations (farming systems) were identified in inland valleys farming, the cost and return are presented on enterprise/farming system basis.

##### 4.1.1 Cost and Return in cassava/fluted pumpkin/okro (CS/FL/OK)

###### Farming System

The common practice in the inland valleys is to plant crops in mixtures. One of such combination is that comprising cassava, fluted pumpkin and okro (CS/FL/OK). Table 1 presents the cost incurred and the return that accrued to farmers having this enterprise. Of all cost items, family labour constitutes an important factor in this crop mixture, making up 48.43 percent of the total variable cost of production. This is followed by the cost of planting materials (31.84 percent). The least cost item is hired labour. This goes to show that the used of hired labour is not very common in inland valley farming. Two possible explanations could be advanced for this result. First, hired labour may be unavailable in the inland valley farming areas. Second, their cost could be beyond the reach of the farmers. The first proposition seems more likely. Most of the inland valleys are located in the hinterland of the study area. This area contained the highest concentration of schools and other non-farm enterprises. Children may be preoccupied with school activities while able-bodies men could be engaged in non-farm activities during cropping season, thus, creating scarcity of labour including the ones for hiring.

On income basis, the results show that on the average, a farmer gets ₦25508.29 from this enterprise per hectare. Spread across the months, farmers cultivating these crops earn ₦2125.69 per month. The crops in the mixture are high value crops in the study area. Fluted pumpkin and okro are highly demanded while cassava could be described as the life wire of almost every household, being consumed in various forms, e.g. foofoo, tapioca, cassava porridge (*oto iwa*) and “ekpang” (Ibibio).

**Table 1: Average cost (₦) and return (₦) per hectare in Cassava/fluted pumpkin/okro (CS/FL/OK) farming system**

Gross Income	3177.48	
Cost Item	Value	Percentage of Total
Family Labour	2745.71	48.43
Hired Labour	294.29	5.19

Planting materials	1805.15	31.84
Depreciation Values of field inputs	824.03	14.54
Total Cost	5669.17	100.00
Gross Margin	2550 8.29	

Source: Field Survey, 2000.

#### 4.1.2 Cost and return in Cassava/cocoyam/maize/fluted pumpkin (CS/CY/MZ/FL) farming system.

Some farmers cultivate a combination of cassava, cocoyam, maize and fluted pumpkin in the inland valleys. Table 2 contains the average costs and returns per hectare of the enterprise/farming system consisting of these crops. The average total income was found to be ₦41468.98 while the average total variable cost was found to be ₦10508.60. Of the variable cost items, family labour make up 41.54 percent implying that this is the main source of labour for inland valley farmers. The cost of planting materials is the next highest variable cost of production. The high value of planting materials may be attributed to the fact that many crops are combined in this enterprise. The low depreciation value which constitutes only 12.91 percent of the total variable cost means that less of the durable assets are acquired by the farmers. It, in fact, may depict low level of mechanization in inland valley farming in the study area.

A gross margin of ₦30960.38 was found to be the average a farmer can obtain from a hectare of this enterprise. This means that a farmer is sure of earning an average of ₦2580.03 per month by cultivating cassava, cocoyam, maize and fluted pumpkin on his/her plot. The higher gross margin obtained when compared with an enterprise containing cassava, fluted, pumpkin and okro indicates the advantage of greater crop diversification, which is higher return

Table 2: Average cost (₦) and return (₦) per hectare in cassava/cocoyam/maize/fluted pumpkin (CS/CY/MZ/FL) farming system.

Total Income	41468,98	
Cost Item	Value	Percentage of Total
Family Labour	4364.78	41.54
Hired Labour	1251.57	11,91
Planting materials	3535.53	33,64
Depreciation Values of field inputs	1356.71	12.91
Total Cost	10508. 60	100.00
Gross Margin	30960.38	

Source: Field Survey, 2000.

## 4.2 Regression Result

### 4.2.1 Regression Results for Cassava/Fluted Pumpkin/Okro (CS/FL/OK) Farming System

The results of the regression analysis for farmers cultivating cassava/fluted pumpkin/okro show that except normalized prices of fertilizer and planting materials, all other inputs are inversely related to the profit level. The coefficients of family labour, hired labour and investment on durable items are  $-0.134$ ,  $-0.079$  and  $-0.32$  which means that if the farmers increase the use of these resources by 1 percent, they can expect a reduction in their farm profit by these margins, respectively. On the other hand, the coefficients of fertilizer and planting materials are positively signed indicating positive relationship between these resources and farm profit. Judging from the magnitudes of the coefficients, a 1 percent increase in the amount of these resources will induce an increase of 0.265 percent and 0.784 percent in farm profit respectively. The result suggests that given the present state of this farming system, it pays to reduce the amount of family labour, hired labour and investment on durable items or their prices and an increase in the amount of fertilizer and planting materials in order to increase farm profit.

$$\begin{aligned} \ln \Pi^* = & 6.082286 - 0.13435 \ln p_{fl} - 0.079069 \ln p_{hl} + 0.26488 \ln p_f \\ & (-0.488)(-0.555) \quad (1.089) \\ & 0.78448 \ln Z_s - 0.32431 \ln Z_i \\ & (2.435)^+ \quad (-1.026) \end{aligned}$$

$$R^2 = 0.17, F\text{-ratio} = 1.75, S.e = 1.30, D. W = 1.60,$$

(+ = Significant at 10 percent level) (N/B: Figures in parentheses are calculated t-ratios).

### 4.2.2 Regression results for cassava/cocoyam/maize/fluted pumpkin (CS/CY/MZ/FL) Enterprise

For farmers combining cassava, cocoyam, maize and fluted pumpkin on the inland valleys, the multiple coefficient of determination ( $R^2$ ) shows that 47 percent of the change in the level of farm profit is explained by the included variables. The Durbin-Watson (D.W) value of 2.35, indicates that there is no serious problem of serial correlation. F-ratio reveals that the equation is different from zero at 1 percent confidence level.

Of all the inputs used, investment on durable items represented by depreciation value is a positive significant determinant of farm profit ( $P < 0.01$ ). The normalized prices of hired labour, fertilizer and planting materials are positively related to farm profit, they are however, not significant. One percent increase in the amount of hired labour, fertilizer, planting materials and investment on durable items is associated with an increase of 0.143497, 0.134048, 0.071857 and 0.541645 in farm profit, respectively. The coefficient of normalized price of family labour is negative. This implies over utilization of this resource. Thus, the quantity of family labour used to produce this crop combination needs be reduced if farm profit is to be improved. In general terms, the low values of the coefficients of the variables excepting investment on durable items, imply that farm profit does not respond significantly to changes in these resources. It could, therefore, be inferred that farmers could increase the level of farm profit by increasing the use of these inputs.



$$\ln\Pi^* = 4.990739 - 0.62799 \ln P_{fl} + 0.143497 \ln P_{hl} + 0.134048 \ln P_f +$$

(-0.263) (1.162) (1.5810)

$$0.071857 \ln Z_s + 0.541645 \ln Z_i$$

(0.351) (3.568)<sup>+++</sup>

R<sup>2</sup> = 0.47, F – ratio = 5.69<sup>+++</sup>, S.e = 0.84, D.W = 2.35,

+++ = Significant at 1 percent level

(N/B: Figures in parenthesis are calculated t-ratios).

### 4.3 Allocative Efficiency

Measures of allocative efficiency of resource use such as average physical product (APP), marginal physical product (MPP), marginal value product (MVP), marginal factor cost (MFC) and elasticities of product (EP) were derived from the different crop enterprises/farming system identified in the inland valleys. These are presented in table 3 and 4.

#### 4.3.1 Allocative Efficiency in Cassava/Fluted Pumpkin/Okro (CS/FL/OK) Enterprise/Farming System.

Table3: Estimates of Efficiency in (CS/FL/OK) Enterprise/Farming system.

Resource	APP	MPP	MVP	EP	MFC (UIP)	Eg	% Divergence
P <sub>fl</sub>	13.63	-0.66	-8.38	-0.13	100.00	108.38	1293.32
P <sub>hl</sub>	52.87	-1.59	-20.19	-0.08	100.00	120.9	598.81
P <sub>f</sub>	1014.62	239.29	3038.98	0.26	11.75	30272.23	99.61
Z <sub>s</sub>	20.07	10.09	128.14	0.78	25.26	102.88	80.29
Z <sub>i</sub>	55.60	-6.50	-82.55	-0.32	135.16	-217.71	263.73
E=0.51	na	na	na	na	na	na	na
UOP= ₦12.21	na	na	na	na	na	na	na

E = Function Coefficient

UOP = Unit Output Price

na = Not applicable

Source: Field Survey, 2000

One of the common crop combinations cultivated by inland valley farmers is a mixture consisting of cassava, fluted pumpkin and okro. Table 3 presents estimates of allocative efficiency or productivity in this farming system. The values of average physical products (APP) of resources show that fertilizer had the highest value. Fertilizer is followed by investment on durable items and hired labour. This indicates that a unit of fertilizer adds most to total output. The high productivity of fertilizer may to some extents, be influenced by the inherent fertility of the wetlands. Inland valleys are known to be high in fertility due to deposition of organic matter. Equally, the relative high value

f investment on durable assets could be due to the fact that the depreciation value was used as a proxy and this was spread over the expected life of each of the items. This results in investment value being relatively small while the output value is comparatively large. The ratio of quantity of output to quantity of fertilizer (APP) should, therefore, be expected to be large. The marginal value products also show a significant high returns to fertilizer with planting materials having positive MPP while other inputs had negative MPP. The results suggest that farmers planting cassava, fluted pumpkin and okro on their plots would increase family and hired labour, and investment on durable items. The marginal value products (MVP) of fertilizer and planting materials were ascertained by comparing the MVP to the unit input price (UIP) or marginal factor cost (MFC). Again, values of efficiency gaps (Eg) and percentage divergence confirm efficiency in the use of fertilizer and planting materials by farmers in contrast to inefficiencies obtained in the use of other resources. The value of function coefficient shows that output was perfectly inelastic. This is indicated by the function of 0.51 which is less than unity.

#### **4.3.2 Allocative Efficiency in Cassava, Cocoyam, Maize, Fluted Pumpkin (CS/CY/MZ/FL) enterprise**

Another important crop combination among inland valley farmers in the study area is cassava, cocoyam, maize, fluted pumpkin mix. The crops in this mix constitute the staples in the area studies. The parameters of productivity or allocative efficiency in the use of farm resources employed in their production are presented in table 4. The average product of fertilizer was more than the average product of other inputs, indicating that a unit of fertilizer adds more to farm output than other inputs. Following fertilizer in magnitude is the APP of investment on durable items, while family labour had the least APP. This tends to suggest that this group of farmers overuse family labour and therefore need to reduce the amount of family labour employed. The marginal physical products for investments on durable assets and fertilizer were significantly higher than that of other inputs. This again, suggests that additional fertilizer and investments on durable items would make greater contribution in increasing production of this crop mixture. The negative marginal value product of family labour implies that additional units of this input if used would reduced total crop output. The excessive use of family labour may arise from the predominance of large households size. Most members of such households would naturally participate in farming activities.

The output elasticities show a decreasing but positive change of output to changes in each of the inputs except family labour which had negative elasticity of production of (-0.06). The function coefficient reveals decreasing positive returns to scale in this farming system. This implies that farmers cultivating these crops or having this farming system are technically inefficient. This situation is further corroborated by the negative efficiency gaps and high percentage divergence obtained. These two parameters, confirm that the farmers were only efficient in the use of fertilizer and investment on durable assets.

**Table 4: Estimates of Efficiency Parameters in Cassava, Cocoyam, Maize, Fluted Pumpkin (CS/CY/MZ/FL) Crop Mixture/Farming System**

Resource	APP	MPP	MVP	EP	MFC (UIP)	Eg	% Divergence
P <sub>fl</sub>	0.6	0.35	3.48	0.06	176.27	-103.48	2973.56
P <sub>hl</sub>	14.31	1.23	12.21	0.14	142.91	-87.79	-719.00
P <sub>f</sub>	205.71	23.72	235.54	0.13	14.00	221.54	94.06
Z <sub>s</sub>	9.16	0.42	4.17	0.07	34.76	-30.59	-733.57
Z <sub>i</sub>	77.88	26.35	261.66	0.56	141.13	120.53	46.06
E=0.82	na	na	na	na	na	na	na
UOP= 9.93	na	na	na	na	na	na	na

E = Function Coefficient

UOP = Unit Output Price

na = Not applicable

Source: Field Survey, 2000

## 5. CONCLUSION

The study reveals the existence of considerable economic benefits in crop diversification, and allocative inefficiencies in inland valleys farming. The results have important implications for the *fadama* development programmes and indeed food self-sufficiency policies pursued by government. Firstly, the results show that it is possible to improve the efficiency of inland valleys farmers through the reallocation of the existing resources in an optimal manner. Policy focus should therefore be directed at correcting some of the key variables. Some of these include imperfect market structures and the socio-economic and institutional constraints such as labour availability that may prevent inland valley farmers from attaining appropriate combination of inputs.

Secondly, major agricultural operations such as land preparation, sowing and weeding, are important for crop production; efficiency of these operation depends on availability of labour. To overcome the shortage of labour, the development and introduction of mechanization is required. Such should be available and affordable to the small-scale inland valley farmers. In this way, this important agricultural system can contribute substantially to the national food and raw materials requirements.

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