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Worth of rice cultivation in the Nile delta

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DESPITE NUMEROUS ADVANTAGES that attract Egyptian farmers to grow rice, the current practice of rice cultivation in the Nile Delta is questionable due to attributed high rates of water diversion. This argument is supported by an increasing demand for water supplies to satisfy the requirements of strategic reclamation plans in Egypt. The new situation necessitates promoting water availability within the Egyptian Nile system by groping towards optimum cropping patterns. Rice is therefore expected to compete for an increasingly scarce water supply according to free market criteria.

In view of the above, the current paper brings the issue of growing rice in the Nile Delta into focus. This is carried out through probing various factors that influence rice cultivation with respect to anticipated water scarcity and perceived economic ramifications. The objective is to work out a rice production limit that would ensure sound land resource use, sustain the local population, and optimise economic returns.

Rice cultivation practice in Egypt

According to the Egyptian agriculture calendar, rice is a summer crop that is mainly grown in the Nile Delta. Rice areas have gradually increased since the construction of the countrywide irrigation network in the nineteenth century. Nowadays, more than one million acres of the Delta lands are annually cultivated with rice. Growing rice is usually rotated with the cultivation of cotton and maize according to two types of crop rotation generally practised within the Nile Delta; the three-year and two-year rotation systems (shown in Table 1).

Attributes of growing rice in deltaic soils

Rice cultivation is concentrated in the Delta primarily because of its soils. The Egyptian Delta is composed of a

thick clay layer, the formation of which is associated with the deposition of sediments that were carried along the Nile course by historic floods. Sediment deposits in the northern (coastal) region of the Delta resulted in a compact muddy clay layer that is almost impermeable. Soil drainage is consequently hampered by heavy clays spread over large areas of this region, endangering the growing of non-flooded crops. The northern strip of the Delta is also characterised by highly saline groundwater due to subsurface intrusion of sea water and/or marine ingress attributed to continuous submergence of this part of the Delta under sea water in historic periods (Hefny et al., 1995).

As a result of these characteristics, it is expected that intensive irrigation of the low-permeable lands in the northern Delta would result in long period floodings, creating a suitable environment for aquatic plants, such as rice and berseem. Rice field ponds would also cause salts to be leached and/or salty groundwater to be pushed away from the root zone. Poorly drained parts of the northern Delta may therefore be regarded as "rice and berseem only" areas, being rather inconvenient for rotation alternatives. Attempts to grow non-flooded crops in such areas are considered problematic, because the soil would be subject to salinity hazards if normal wet and dry irrigation cycles are applied.

The remaining area of the Delta (the southern part) varies in its suitability for rotation crops. For much of this land there are few alternatives to rice, the most common being cotton and maize. Because intermediate soils prevail in the southern Delta, the choice to grow rice can be more economically determined than on poorer soils where there is little if any alternative. Rice grown in the southern Delta may, therefore, be considered as useful for a cash crop as for its benefits in leaching salts and/or improving soil conditions.

Table 1. Rotation systems generally practised within the Nile Delta

Water application onto local rice fields

As previously shown, rice is commonly grown in the Delta under continuous flooding. Throughout most of the growing season, extending from May to October, rice fields are submerged under standing water layers of variable depths. The outlined irrigation process reflects the intense need of rice for water diversions. Exposed to temperatures in the range of 30-40°C, rice field ponds are subject to excessive evaporation in addition to percolation, resulting in significant rates of water loss. Almost fifty percent of the amount of water diverted to rice fields is consumed in terms of evapotranspiration and the rest is lost via percolation (EWUP, 1983).

Nevertheless, percolation may not be considered a total loss with respect to the irrigation water budget. The reason is that, on one hand, percolating water can be retrieved through pumping from the underlying closed aquifer; on the other hand, water infiltration into soil helps with leaching salts away from the root zone. However, an accurate determination of the percentage of water used in the leaching process with respect to the total diversions to rice fields is deemed a cumbersome approach. This is due to the flooding conditions that characterise the local practice of rice cultivation, according to which water output components (e.g. runoff, evaporation, percolation) are mixed up and may not be precisely distinguished.

Importance of rice to Egyptian farmers

Rice is known to be a wholesome, nutritious and versatile food. Its content of complex carbohydrates is converted by the body's digestive processes into glycogen, which is stored in muscle tissues and released as energy when activity demands. Being the food staple of most Egyptians, rice is locally consumed at a rate of 35-40 kg/capita/annum.

Moreover, according to a sample of interviewed local farmers, rice is considered an easy cultivation of almost guaranteed results. Local rice productivity is estimated at about 3.5 tons/acre, resulting in an annual demand of 1.8-2.4 million tons of rice to satisfy the consumption of about sixty million persons countrywide. In short, the current practice of rice growing, requiring minimum farming efforts, is considered able to satisfy farmers' daily nutritional requirements in addition to its ability to wash salty lands.

A tendency to grow large patterns of rice throughout the Delta is additionally created among farmers due to the free delivery of irrigation water, according to which rice becomes of better profitability compared to other crops. The distortion in making cropping decisions, thus created, promotes the expansion of rice areas despite shortcomings regarding water requirements for the country's strategic reclamation plans. In the following sections, it will be shown that if an economic value is imputed to scarce water supplies, diversions to rice fields would be regarded as inefficiently used.

Estimating Nile water value

The economic assessment of crop production necessitates recognising the value of water used in irrigation. Rural

water pricing is not practised in Egypt according to a rule implying free provision of irrigation water to farmers. However, given the underlying natural resource constraints facing the country, it is deemed necessary to ensure an efficient use of water through initiating a value that reflects the vital concern for this most important limiting factor of Egypt's agricultural production. In this context, the economic value of water is believed to include three main components (Ahmed, 1995):

- operation and maintenance expenditure as well as capital expenditure for replacement (OM&R),
- opportunity cost, resulting from the limited availability of water (the economic price), and
- investments in the existing irrigation and drainage infrastructure (considered sunk cost).

The Operation, Maintenance and Replacement Cost (OM&R) represents the expenditure incurred by the Egyptian Government to maintain services provided for the irrigation and drainage system. Because these investments are considered a tradable input to agricultural production, farmers are required to reimburse payments made by the Government in this regard. Several approaches were adopted in the context of determining the due cost recovery. A value of LE¹ 0.03/m³ was obtained as an approximate figure of OM&R averaged over different approaches to calculate the system cost (WSP, 1993).

It is also believed that water has an opportunity cost only if the supply is short. That is, in case of ample water, no alternative water use is considered, thus yielding a zero opportunity cost. In the case of scarcity, the best alternative use of a new supply of irrigation water is envisaged through one of the following courses of action:

- Increasing irrigation quantities on existing cropping patterns, which implies diverting more water to the current patterns in order to obtain maximum yields, hence maximum economic returns.
- Changing cropping patterns to more water consuming crops, e.g. expanding rice areas all over the Delta.
- Reclaiming desert lands and maintaining the current profile of cropping patterns in the traditionally cultivated alluvial lands.

Scrutinising these alternatives would reflect the fact that increased irrigation quantities are unlikely to generate benefits because the heavy clay soils of the Delta are generally over-irrigated for leaching purposes. Moreover, the marginal benefits resulting from cropping pattern changes, which become possible with increased water supply, are reckoned to represent the short-run opportunity costs of water. It is finally assumed that the long-term opportunity costs are represented by the marginal benefits resulting from land reclamation projects². Since generic land reclamation projects are considered profitable at water prices below LE 0.07/m³ at 12 percent discount rate (WSP, 1993), the opportunity cost of water may be rated at LE 0.07/m³, thus bringing the cost of water to a total of LE 0.10/m³.

Economic weighing of rice against alternative crops

The valuation of irrigation water, thus carried out, allows the generation of an economic trade-off between crops, based on the real costs of domestic resources used in their production. The weighing process entails computing the net benefit for each of the three alternative main crops in the Egyptian Delta; rice, cotton and maize, as delineated in Table 2³. The term "Domestic Resource Cost" (DRC) is then introduced for assessing the competitiveness of different crops and is calculated by dividing the economic value of domestic resource inputs by the economic value added through the production of each crop. According to this definition, it is expected that, for a certain crop, the less value a DRC below 1, the more promoted is the national cost advantage brought about by using the country's domestic resources in producing the specified crop. Results show that while the introduction of an opportunity cost for water in the trade-off process reveals a non-competitiveness of the rice growing practice (DRC=1), it demonstrates that the cultivation of cotton is strongly competitive (DRC=0.6) and that of maize moderately competitive (DRC=0.8). On the other hand, the competitiveness of rice cultivation may be considered relatively robust if the current policy, which implies excluding the opportunity cost of water from economic transactions for supply sufficiency, is taken account of. In this case, DRC for rice would equal 0.52⁴, while that for maize 0.61 and for cotton 0.54.

Discussion and conclusions

Through the present research, it is endeavoured to assess the controversial issue of growing rice in the Nile Delta. Controversy stems from the fact that, on one hand, local rice cultivation is known to consume large amounts of water, which will alternatively be needed for implementing the country's ambitious reclamation plans. On the other hand, under the current agricultural policy, Egyptian farmers consider rice a profitable crop and tend to expand its cultivation throughout the Deltaic region. The research objective is to determine the extent to which growing rice in the Nile Delta may be considered a worthwhile practice in the light of increasingly constrained water supplies.

The study showed that, due to the presence of heavy clay soils and salty groundwater, growing rice is inevitable in parts of the northern Delta despite attributed high rates of water diversion. In the remaining parts of the Delta, the choice of growing rice or alternative crops was deemed more easily traded off according to soil conditions and market crop prices, taking into account the importance of rice to the Egyptian farmer for being an easy cultivation that is able to secure his elementary food and wash his land. It was additionally shown that the free delivery of irrigation water promotes rice profitability, thus favouring farmers' tendency to expand rice growing throughout the Delta. In the light of these facts, an endeavour to impute a value to irrigation water was carried out with the objective of

allowing an economic trade-off between rice and alternative crops, namely; maize and cotton. The undertaken analysis was based on an estimation of the real costs of using domestic resources in producing each crop. Results showed that due to its high water requirements, rice proved economically non-competitive and was ranked last with respect to cotton and maize when the economic value of irrigation water was included in the analysis. Conversely, rice fared well when no opportunity cost of water was considered (the status quo).

In view of the foregoing discussion, and given the absence of a water pricing system in Egypt, the following conclusions could be drawn:

- The determination of rice areas in the Nile Delta should be worked out from north to south.
- Boundaries of the area assigned for rice cultivation should be set to the south of the no-alternative-to-rice areas, taking into consideration that the total area of rice cultivation should satisfy the needs for local consumption and soil improvement.
- The cultivation of some 600-700 thousand acres with rice is expected to yield 2.1-2.45 million tons, thus achieving an actual self-sufficiency in rice.
- Rice cultivation beyond the specified limits should be financially penalised.
- To bridge future gaps between the above estimated production and the increasing demand resulting from population growth, one or more of the following courses of action should be considered:
 - Augmenting rice field productivity (must exceed the actual 3.5 tons/acre rate).
 - Decreasing the per capita consumption of local rice, currently estimated at 35-40 tons/annum. This necessitates offsetting the created shortage using alternative food patterns of equivalent nutritional value and taste acceptability (e.g. cheap varieties of exported rice).
 - Promoting the plantation of short age rice varieties, with the objective of reducing water losses and/or increasing rice harvest per season.

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R WATER RESOURCES: AHMED

- 1 LE = Egyptian Pound = US\$ 0.294
- 2 This assumption is supported by a lack of attempts to calculate the marginal benefits from alternative uses of irrigation water within other economical activities.
- 3 Data used in the computation process were surveyed by the Principal Bank for Development and Agriculture Credit (PBDAC) with respect to price levels at the end of 1991.

4 $DRC = (237 + 114.8 + 360) / 1362.9 = 0.52$

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Table 2. Budgets of main summer crops in the Egyptian Delta (as surveyed by PBDAC)