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AGRICULTURAL INTENSIFICATION: CONCEPT, PROSPECTS,*
AND RATIONALE: THE CASE OF COTTON

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Agricultural Intensification: Concept, Prospects and Rationale: The Case of Cotton.

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Introduction:

Demand for agricultural commodities, in Egypt, has been largely expanding over the last twenty years. This is basically attributable to two main factors, namely: increasing per capita real income and rapidly growing population. This substantial increase in demand, however, was not matched by a comparable expansion of supply. Both the quantity and quality of available agricultural resources remained relatively stagnant and, in some cases, tended to deteriorate. The unsatisfied demand for agricultural commodities resulted into an increased tendency to import agricultural products and higher prices for these products, particularly foodstuffs and animal feed. These alarming features of recent Egyptian development emphasized the need for expanding agricultural resources both vertically and horizontally. However, experience of vertical expansion vs. horizontal expansion in Egypt has revealed that the latter is often confronted with economic, social, administrative and technical

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constraints compared with the former. Thus, leading the policy makers to increasingly emphasize intensification as a tool for accelerating growth rates of agricultural output, particularly in the short run.

Technical vs. Economic Conceptualization of Agricultural Intensification:

Technologists define agricultural intensification as the increase in the number of consecutive crops grown on a given piece of land during the agricultural year. According to this narrow definition, agricultural intensification may be achieved through modifying the crop composition and crop rotation in order to apply two major procedures, namely: intercropping and cultivating short duration crop varieties. This definition implies that technologists view cultivable land as the most binding factor of production. This inference is further supported by the observation that they tend to express all variables in terms of the unit of cultivated land. Almost all published statistics about yield, costs of production, fertilization rates, labor employment, ... are conventionally related to the feddan. Furthermore, examination of the data published
by MOA supports the view that land is considered as the most constraining agricultural resource - almost all published figures for inputs utilized are linear transformations of cultivated land. Measuring crop intensity or the degree of intensification as the ratio of the cropped area to the cultivated area is a further evidence that technologists view land as the most binding factor of agricultural production and hence consider intensification as a mean of increasing the efficiency of using this scarce factor.

Economists, however, adopt a broader definition for agricultural intensification. Most of them do not significantly distinguish between intensification and vertical expansion of the agricultural process. The two concepts refer to a set of production procedures leading to increasing output given the amount of resources used, or achieving the same level of output with less resources. Thus, intensification is not an end by itself, it is rather a mean to accomplish higher levels of production and income through increasing efficiency in utilization of existing resources.
Despite the difference of scope, both definitions seem to agree that the physical volume of agricultural output is the major criterion for measuring the performance of the agricultural sector. The impact of intensification policy on output quality has been neglected, although changes of quality affect income generated from agriculture.

Discrepancy between Technical and Economic Concepts of Intensification:

From the preceding section, we may conclude that technologists consider intensification as a way of maximizing output per unit of cultivated land, while agricultural economists view it as a way of maximizing output from a given set of resources. The two approaches would have probably led to the same optimal pattern of production had land been the only binding factor with "unlimited" supply of all other factors of production in agriculture. However, under the present Egyptian conditions, land can no longer be considered as the only binding factor. Recent structural changes in the economy led to changing the
relative scarcities of agricultural resources. Water and more recently labor resources have increasingly become constraining. Agricultural labor market is no longer a typical case of excess labor supply. The premise of rationalization of agricultural land use only disregarding all other agricultural resources on the grounds that they are all in excess supply can no longer be justified.

Thus, the gap between the scopes of the two definitions has increasingly widened and a reconsideration of the approach to intensification is necessary to allow for changing relative scarcities of inputs and for the effect on quality of output.

Alternative Approach to Agricultural Intensification:

As a guide to the rational utilization of available agricultural resources, it is useful - instead of aiming at maximizing output per unit of cultivated land, or more broadly output from a given set of resources - to compare different crop mixes and crop rotations with respect to two kinds of contributions:
1) net contributions to Egypt's foreign exchange earnings, and

2) net contributions to national income earned by Egyptian land, labor and capital.

Obviously, it is more rewarding to expand a crop which contributes a large amount to foreign exchange and national income rather than one which contributes a small amount. Moreover, it is important to avoid the mistake of promoting a crop which although earning foreign exchange on a gross basis, has net foreign exchange earnings that are very low or even negative and makes a net contribution to national income that is much lower than land, labor and capital could earn producing something else.

Emphasizing the number of crops or the physical volume of output as a criterion for measuring the efficiency of utilization of the given agricultural resources might lead to erroneous decisions such as growing crops which although yielding large physical output are very costly to produce or growing low quality, high yielding crop varieties which will be difficult to market domestically or externally unless
accepting low prices which might affect the sales proceeds.

It is suggested to use two criteria for estimating the returns to the economy. They are:

1) The net foreign exchange earnings per L.E. 1 of domestic resources used in production, to assess the contribution to foreign exchange earnings, and,

2) The net contribution to value added per L.E. 1 of domestic land, labor and capital used in production, to assess the addition to national income.

Note that in assessing the contributions to the economy by these two criteria, trade-offs may be allowed to take into consideration the contribution of different crop mixes to other objectives such as food security.

Note also that net additions to foreign exchange earnings or to national income as calculated on the basis of domestically prevailing prices do not reflect the true cost and return to the economy. As we all know the domestic price structure is subject to distortions due to tariffs, excise taxes, subsidies

(\#) See the Appendix for further elaboration of these criteria.
and controlled prices, and consequently it does not reflect the true value to the economy of tradable goods which are potential exports or substitutes for imports. The international price is a more accurate indicator of the true value of an export good, and it is also a better guide to the true value of a domestic product, which could be exported but is used domestically. Similarly, the international price represents the true value to the economy of an import and it also reflects the true value of a domestic product which replaces an import in domestic use. Therefore, international prices should be used to value both tradable inputs and outputs in calculating the suggested criteria. Similarly, domestic resource costs should be valued at their opportunity cost or shadow price reflecting their social marginal productivity - e.g. water should not be considered as a free factor but rather as a highly constraining one which should be charged a price reflecting its social marginal productivity.

Accordingly, prices at farm gate should be revised to reflect the relative international prices of different inputs and outputs and to provide appropriate incentives.

(*) Note that revision of relative prices should be generalized to all sectors in order to avoid further distortions of the agricultural price structure compared to that in other sectors.
to the farmers to adopt the crop rotations and crop compositions which appear to be more profitable to the economy by the two criteria. Alternatively, the farmers may be given directly additional incentives to grow the crops which seem to be most profitable to the economy.

Intensification in Field Crops: The Case of Cotton:

The two major procedures for intensification in the field of growing cotton are: intercropping cotton with summer onion and growing short duration cotton varieties (short staples). The two procedures will be briefly examined to try to assess their contribution to farmers' income and to the national economy.

1) Intercropping in Cotton Rotation:

Other crops may be grown as companion crops with cotton. The most common combination is to grow summer onion with cotton. The usual procedure is to plant onion in December or beginning of January and the crop is harvested in June(\(\text{(*)}\)). This means that the

two crops overlap for a short period of time, which may adversely affect the yield and quality of both intercropped onions and cotton compared to the yield of these crops when grown separately, due to the following considerations:

1- The summer onion may host pests that harm cotton at its early stages of growth.

2- The traditional harvesting technique of onion damages cotton by more than 10%.

3- The summer onion intercropped with cotton has to be picked earlier than when grown separately, thus giving onion of poor keeping quality.

However, the advocates of intercropping cotton with onion argue that, although cotton and onion yields suffer from intercropping, net returns from these combinations are higher than from cotton planted separately. The conclusions of the Interplanting Committee Report support

(continued)
this argument. However, these conclusions are based on a survey of four districts in Gharbia Governorate and cannot be generalized to all cultivated cotton areas. Other arguments in support of this view are based on the belief that there are economies in using certain inputs and factor of production services: the amount of water required does not grow in proportion to the quantity produced of both crops; there is labor, machinery and draft animal saving in the process of preparing land for planting two crops rather than one. Finally, growing summer onion allows planting cotton earlier than planting it after a catch crop of clover and this is more beneficial to cotton.

If intercropping was profitable, how would we explain the downward trend of the area of cotton intercropped with summer onion observed over the period 1971 to 1980? One may try to explain this phenomenon, although the reasons for this trend are not explicitly known and there are no data to support - or refute - them. The suggested factors explaining this trend are:

1- The farmers know well that a temporary catch crop of clover before cotton is more profitable than intercropping any other crop with cotton. In addition, clover is one of the legumes group which increases
the fertility of land and thus reduces the need of cotton for chemical fertilizers, especially nitrogen.

2- Cotton and summer onion requirements of fertilizers are conflicting: cotton needs a lot of nitrogen to grow at a time when onion does not need it anymore. However, onion absorbs part of these fertilizers, thus increasing the rate of fertilization needed to overcome the adverse effects of intercropping on land fertility. The resulting higher fertilization cost might not be justified by the additional returns due to intercropping.

3- Cotton and summer onion requirements of water are also conflicting.

4- The increasing shortage of labor supply along the year, particularly at the planting and harvesting seasons of the principal crops, is more acute in case of intercropping than when separating crops, with obvious effects on increasing labor cost and decreasing efficiency in serving individual crops.

From the previous discussion, it appears that in the case of cotton, the assessment of intercropping is not clear-cut, due to the lack of information.
However, the observed downward trend of the intercropped cotton area is an indicator that it might not be as beneficial as some people tend to think. Intercropping reduces both cotton and onion yields and also depresses the crop quality. It is true that the total value of intercropped cotton and onion exceeds the value of cotton alone, but the probable increase in labor requirements and fertilization rates will reduce the net returns to the farmers from intercropped cotton, particularly in farms which rely on hired labor.

From the national economy's point of view, one may add to the previous factors that:

1- With increasing labor shortage in agriculture, higher labor requirements in intercropping might lead to withdrawing workers from other activities which are more profitable to the economy.

2- It has been shown that the quality of Egyptian cotton was significantly depressed. Qualities like extra, fully good extra and fully good have virtually disappeared. (☆) Egypt has been known for its

very fine quality cotton. This alarming trend has a negative effect on export prices and on the monopolistic power that Egypt may have in the world market.

To increase the cropping intensity of cotton, an alternative technique to intercropping is to increase the number of cotton trees per feddan. The usual pattern in preparing land for cotton cultivation is to furrow 13 to 14 rows per 2 kassaba (around 7 meters) and plant the cotton seeds on one side of each row. The alternative technique is to furrow 9 to 10 rows per 2 kassaba (7 meters) and plant the cotton seeds on both sides of each row. This technique is more suitable for low fertility lands. It allows to increase the number of trees per feddan and hence leads to an increase of output by 10 to 20% without any significant increase in labor cost. However, an increased rate of fertilization is required. This is generally true even if the first technique of planting cotton is followed, because land fertility has drastically changed after the construction of the High Dam and also because the new varieties of certified cotton seeds require a higher rate of fertilization.
Finally, mechanization of cotton production, particularly for land preparation, seed planting and irrigation may significantly reduce costs through reducing labor costs and wastage of inputs and through enabling farmers to complete land preparation—especially if a temporary catch crop of clover precedes that of cotton—in an appropriate time.

2) Growing Short Duration Cotton Varieties:

Cotton is usually planted in March and picking starts in mid-or late August and is usually completed by the end of September or mid—October. Cotton commonly follows a temporary catch crop of clover, from which one or two cuttings are taken, but in some localities it may follow an early winter crop of broadbeans, onion or other crops. So it can be said that taking into consideration the time required for land preparation before planting cotton, it is not possible to grow before cotton a full-season winter crop, thus cotton occupies land for almost a year. Any attempt to reduce the period required by the cotton crop to be able to cultivate a winter crop before cotton is a tendency to intensification. The short staple varieties which may be planted by the end of May or beginning of June enable the farmers to grow
a full winter crop. Furthermore, experiments of growing American short staple varieties undertaken by the Ministry of Agriculture in the new lands of Western Nubaria, using highly mechanized techniques showed that the yield per feddan of short staple cotton is relatively higher than the average yield of long staple Egyptian varieties. (X)

In addition, there is evidence that these varieties are better suited for the Egyptian spinning industry. Egyptian extra long and long staple varieties are exported at a very high price and are used by Western countries to spin fine yarns. This same type of cotton is used domestically to spin medium and coarse yarns. Therefore, it would be logical to replace this fine cotton with short staple varieties which are more suitable for spinning the lower count fibers that Egypt is producing. This, however, should not be taken as an argument for expanding domestic production of short staple varieties. Several considerations should be accounted for before such a decision is taken.

(X) The contribution of Dr. Ibrahim S. Aly, Lecturer Faculty of Ag., Shebin El-Kom, in preparing this section should be acknowledged.
Egypt so far has not been able to grow short staple cotton seeds. Long experiments with plant breeding, which might extend up to ten years, are required before growing such seeds. Thus, expanding the area cultivated with these varieties is not likely to be achieved in the short run.

2. Importing such seeds is uneconomical as the cost of imported American seeds per feddan varies between L.E. 40 - if mechanically planted - and L.E. 90 - if manually planted.

3. The available ginning machinery is not appropriate for ginning such varieties and expansion of their production would require a completely new type of machinery. (x)

Thus, although the yield in such varieties is higher than that of Egyptian long staples, substitution of short staples for long staple cotton for the purpose of domestic industry involves high costs which might make it more economical to import such varieties rather than try to grow them domestically.

(x) This information was obtained from discussions with Dr. H. El-Deedy, Director of the Cotton Research Institute, MOA.
Conclusion:–

Emphasizing the physical volume of output as a criterion for measuring the efficiency of utilization of our limited agricultural resources does not necessarily lead to an optimal pattern of resource allocation in the agricultural sector. Other criteria should be taken into consideration such as the contribution of different crop mixes to value added, to foreign exchange earnings and to other objectives that the community may have – e.g. food security.

Intercropping cotton with onion or growing short duration cotton varieties, which are the two major procedures for intensification of cotton production, should be further examined to try to assess their impact both on the farmer and on the national economy. The additional costs required by these techniques and the resulting deterioration of cotton quality might not be justified by the additional returns due to a larger physical volume of output. The available information is not sufficient to permit a clear-cut conclusion concerning these techniques. But there is enough evidence to justify doubting their effectiveness in increasing efficiency of resource use.
Appendix

Further Notes on the Suggested Criteria

The suggested criteria will be respectively denoted by FXR and VAF.

1) The foreign exchange criterion, denoted by FXR, shows the amount of net foreign exchange earned from L.E. 1 worth of domestic resources engaged in producing this exportable crop. This indicator is calculated as the ratio of net potential foreign exchange earnings at international prices to domestic resource costs valued at shadow price. Thus, for a given crop mix:

\[
FXR = \frac{\text{Value of traded crops} - \text{Value of traded inputs}}{\text{Value of factors of production} + \text{Value of nontradable inputs}}
\]

The numerator is a net increment of foreign exchange indicator converted at a shadow exchange rate (probably higher than L.E. 0.70 per dollar). The domestic resource cost in the denominator includes two elements: 1) the value of nontradable inputs (e.g., intermediate services like internal transportation and drainage, intermediate goods like water and finally depreciation of domestic capital); 2) the value of the services of the domestic factors of production (wages of labor + rental of land +
domestically paid interest + imputed returns to capital) employed for the production of a given crop mix. These items should be valued at estimated prices representing opportunity costs.

The FXR criterion shows the amount of net foreign exchange that L.E. 1 worth of domestic resources can earn if they are allocated to the production of a given tradable crop mix rather than to another use. From the standpoint of the goal of increasing foreign exchange earnings, it is evident that allocating resources to a crop mix with a high FXR indicator contributes more to the economy than using these resources to produce one with a low FXR. Moreover if we accept that the shadow rate of exchange used represents a reasonable guide for policy, the FXR indicator should be compared to the standard of 1. A tradable crop with an FXR indicator of significantly less than one is actually using up L.E. 1 worth of domestic resources to earn or save less than L.E. 1 worth of net foreign exchange.

Note that FXR is the inverse of another concept in the literature - the domestic resource cost of foreign exchange (DRC/ $) after converting the numerator in FXR into foreign currency using an appropriate exchange rate. The DRC/$ may be considered as an implicit rate of exchange within the activity producing the tradable crop and may be compared with the opportunity cost of foreign exchange. The concept of FXR is preferred in order to keep all measures in L.E. and to represent higher net foreign exchange earnings or savings by a higher FXR measure.
Such a crop should not be encouraged to expand production. On the contrary, if the FXR indicator for a certain crop mix is significantly more than one, production of the corresponding crops should be encouraged since it is using a L.E. 1 worth of domestic resources to earn-or save-more than L.E. 1 of net foreign exchange.

2) The national income criterion denoted by VAF is the value added at international prices earned by L.E. 1 worth of domestic land, labor and capital, valued at domestic prices. The numerator is an estimate of value added expressed in international prices and nontradable inputs at domestic opportunity cost. The denominator is the value of the services of the domestic factors of production (wages of labor, rental of land, domestically paid interest, and imputed returns to capital). Domestic factor costs should be valued at opportunity cost thus, for a given crop mix:

\[
VAF = \frac{\text{Value of traded output} - \text{Value of tradable and nontradable inputs}}{\text{Domestic factor cost}}
\]

The numerator and the denominator are therefore different kinds of measures of factor incomes. The numerator calculates the value added available for factor incomes,
when all tradables are valued at international prices. The denominator calculates the cost of using the domestic factors, as measured by their incomes at domestic prices or opportunity costs. The ratio between the numerator and the denominator is thus a simple measure of the efficiency with which factors of production are being allocated.

If the factor incomes earned in producing a certain crop are higher at international prices than at domestic prices, the VAF ratio is greater than one. If the factor incomes are lower at international prices than at domestic prices, the VAF ratio is less than one. If VAF is significantly greater than one, expanding this crop for exports increases absolutely the national income earned by domestic factors. Moreover, from the standpoint of the goal of raising national income, the higher the VAF indicator for a tradable crop, the more desirable it is to expand this crop for exports. But if VAF is significantly less than one, producing this crop lowers absolutely the national income and other crops should be expanded instead.

Finally, note that although the FXR and VAF criteria measure contributions to different objectives, they are related. Given the equilibrium exchange rate,
if one of the two indicators is larger than unity, the other one must also be greater than unity. The ranking of alternative crops by VAF may differ significantly from the rankings by FXR, however, according to the amount of nontradable inputs (e.g., water, transportation, or drainage) used.

This can be shown if we note that the same value of non-tradable inputs, which is subtracted from the numerator in FXR (net foreign exchange earnings) to obtain the numerator in VAF (value added available for distribution to the workers, the land and capital owners), is added to the denominator in the VAF (the domestic factor cost) to obtain the denominator in the FXR (the domestic resource costs). Thus, if:

\[ \text{FXR} = \frac{\text{Traded Output} - \text{traded inputs}}{\text{Domestic factors + nontradable inputs}} \geq 1 \]

then

\[ \text{VAF} = \frac{\text{Traded Output} - \text{traded inputs} - \text{nontradable inputs}}{\text{Domestic factors}} \geq 1 \]

because in VAF, the same value of nontradable inputs has been subtracted from both the numerator and the denominator of FXR.