Reformulation of Agricultural Sustainability*

Nikos Pelekanos (nikospel11@gmail.com), Konstantinos Papoulakos, Georgios T. Manolis and Dionysia Panagoulia

National Technical University of Athens, Greece

Department of Water Resources & Environmental Engineering, School of Civil Engineering, National Technical University of Athens, Greece

1. Abstract

All definitions of Agricultural sustainability agree on that it has economic, environmental and social aspects while the economic aspect is examined taking into consideration viability in strictly microeconomic terms. Energy input is usually analyzed into Labor, Machinery, Fuel, Nitrogen, Phosphorus, Potassium, Seeds, Irrigation, Herbicides, Insecticides, Electricity and Transport. However, in most countries under food stress labor input is high while agricultural production has low contribution from the rest of the energy input variables which impacts productivity in a negative way. Since most of these countries have negative trade balances and foreign exchange shortages, economic viability must be augmented in a way that influences these national account balances which impede the viability of microeconomic aspect examined usually. The augmentation methodology proposed is the redefinition of cultivated land by the obligatory inclusion, as an integrated component, of additional land where biomass/biofuel cultivation takes place. The target of this redefinition is (a) to cover the cost of the rest of the energy input variables by a crop which reduces imported fuel and allows for the foreign exchange earned to be transferred to the import of these missing quantities while retaining the same level of imports (b) to lower in a sustainably stable way crop prices in general and (c) to insulate crop production from the local and local fluctuations of energy cost. The pros and cons in terms of general sustainability are examined.

2. Introduction

General WEF Sustainability [1], [2], [3], [4] includes Agricultural Sustainability [5], [6], [7], [8], [9], [10], [11] whose increase is tied up with a corresponding Sustainable Food Security increase [12], [13], [14], [15]. The operational diagram connecting these global processes is as below, where Supply connects to Demand via Trade Policy interfacing with the Region/Country level which may rely in part upon some form of Open Market Operations. This leaves open the matter of what policy should be followed at Region/Country level so as to control the impact of the critical interface formed, which may, under adverse economic conditions, be inimical to the localized economies.
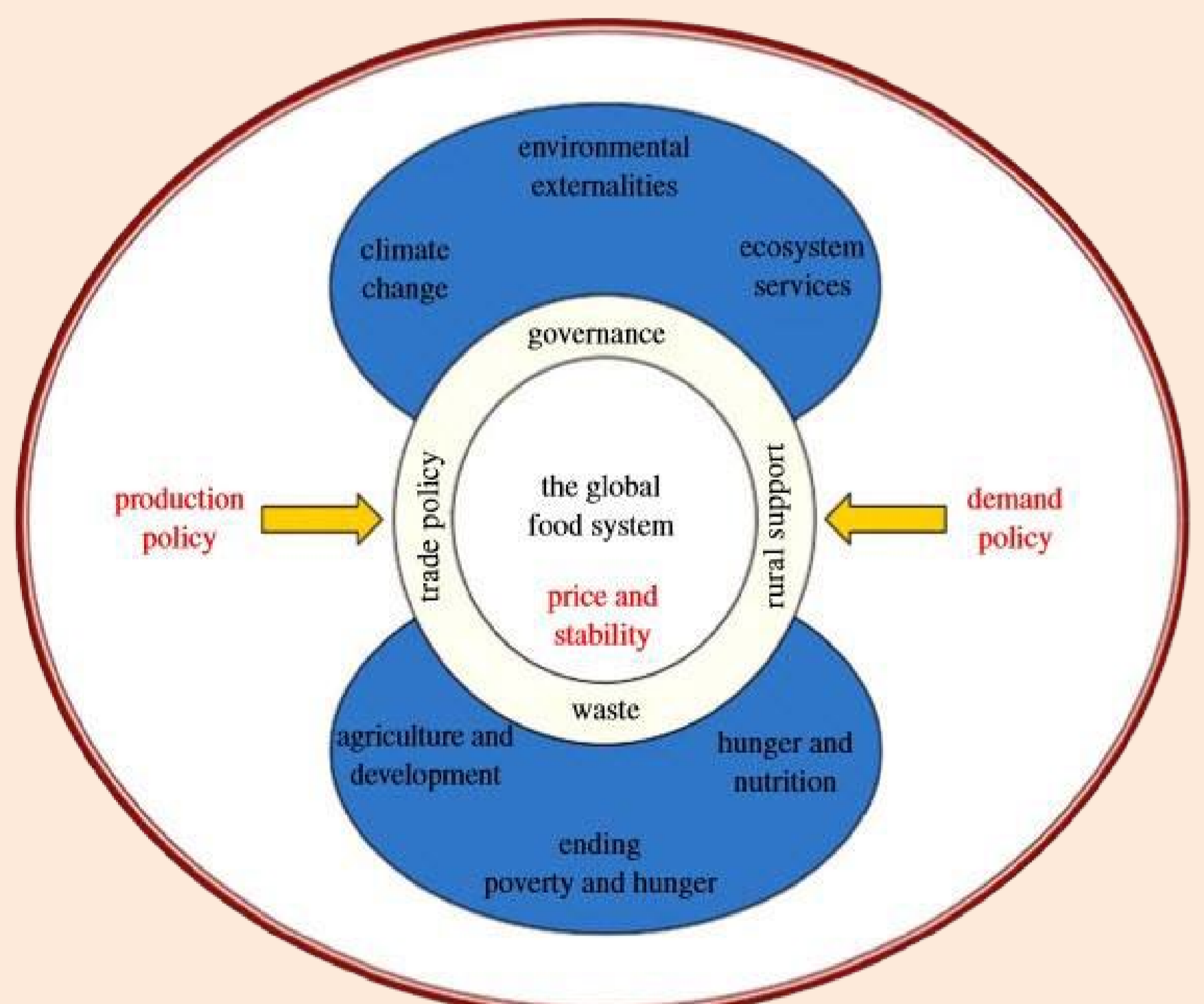

Figure 1: Modified from [16]

3. Objectives

We examine the component of General WEF Sustainability, Agricultural Sustainability, with the aim of zeroing Imported Agricultural Products and increasing Imported Agricultural Energy Input [17], [18], [19], [20], [21], [22], [23] at Region/Country level which should occur under the constraint of influencing positively the country's existing foreign trade balance X-M.

This implies that in terms of total Agricultural Energy Input, $E_{AGRICULTURAL\ ENERGY}$, only the imported part, E_{IMPORT}, is taken into primary consideration, i.e. the sum of Machinery (E_1), Fuel (E_2), Nitrogen (E_3), Phosphorus (E_4), Potassium (E_5), Seeds (E_6), Herbicides (E_7), Insecticides (E_8), Electricity (E_9) and Transport (E_{10}) while the local provenance components, E_{LOCAL}, Labor (E_{11}) and Irrigation(E_{12}), are of secondary consideration.

The result sought is region/country level Agricultural Self-Sufficiency by economic policies that are endogenous within this level by restricting this application to cases where the Region/Country is structurally weak in the main economic variables involved in the formation of trade balance X-M. There is a some amount of support for region/country Agricultural Self-Sufficiency [24], [25], [26], [27], [28], [29]. The main line of reasoning rests on the Trade Dependency generated by Food Insufficiency [30] which, coupled with the weak geopolitical position of most of the importing countries, creates a perpetual state of comparative disadvantage with respect to the food exporting countries.

This research is formulated from the "Agricultural Self-Sufficiency under Sustainability: An Economic Analysis with Application to African LDCs" by Kalomoira Zisopoulou, Nikos Pelekanos, Konstantinos Papoulakos, Georgios T. Manolis and Dionysia Panagoulia (work in progress).

4. Materials & Methods

The way proposed is to substitute part of Oil Imports by Government subsidized locally produced biofuel. The import cost saved from this substitution will be transferred to the import account for agricultural E IMPORT which will lead to crop intensification and/or increase of cultivated areas under sustainability restrictions[18], [20], [23], [31], [32], [33], [34], [35], [36]. This will leave the size of the trade balance initially invariant and, as biofuel production is stabilized at a level where the intensification/cultivated area increase eradicates Agricultural Imports, the negative tradebalance will be reduced.

In essence, the Central Government borrows from the Central Bank a sum of money S_0 in LCU which is enough to start off the agricultural production of biofuel land and its processing in a quantity Q of biodiesel / fuel for Government owned land after a period of 18 months. This quantity Q should be sufficient to finance the crop intensification and/or increase of cultivated areas into Government owned land under sustainability restrictions to the degree that, after an additional 18 month period, the targeted agricultural imports $Q_{AGRICULTURAL\ IMPORTS}$ will be replaced with local production leading to Agricultural Self-Sufficiency. Part of S_0 will be converted into foreign exchange, $S_{0\ EXCHANGE}$, which will cause a "bump" $M_0 = S_{0\ EXCHANGE}$ in the negative trade balance X - M and will probably be carried over as additional external public debt. The annual production of Q would entail the following costs Q_C:

a. The energy input components of Agricultural Production, E_{IMPORT} (where Machinery will be replaced by repair costs) and E_{LOCAL}
b. The energy inputs of processing into biodiesel / fuel $E_{PROCESSING\ IMPORT}$ and $E_{PROCESSING\ LOCAL}$
c. The S_0 amortization comprised of $S_{0\ EXCHANGE\ AMORT}$ and $S_{0\ LOCAL\ AMORT}$

Therefore $Q_C = Q_{C\ EXCHANGE} + Q_{C\ LOCAL}$ where $Q_{C\ EXCHANGE} = E_{IMPORT} + E_{PROCESSING\ IMPORT} + S_{0\ EXCHANGE\ AMORT}$ and $Q_{C\ LOCAL} = E_{LOCAL} + E_{PROCESSING\ LOCAL} + S_{0\ LOCAL\ AMORT}$. Assuming that the Government will sell at a price equal or lower to Q_C the lowest price it can charge will be $Q_{C\ EXCHANGE}$ so as to maximize the M reduction and reduce the X − M negative balance. At the same time oil imports $P_{OIL\ EXCHANGE}\ Q_{OIL}$ will be reduced to $P_{OIL\ EXCHANGE}\ (Q_{OIL} - Q)$ and the import cost of Agricultural Products, $P_{AG\ PROD\ EXCHANGE}\ Q_{AGRICULTURAL\ IMPORTS}$, will become zero. Hence

CHANGE OF M TO M-ΔM

$$\Delta M = P_{OIL\ EXCHANGE}\ Q + P_{AG\ PROD\ EXCHANGE}\ Q_{AGRICULTURAL\ IMPORTS} - Q_{C\ EXCHANGE} > 0$$

Figure 2: Method Flow Diagram

5. Results & Application to African Less Developed Countries (LDCs)

The African LDCs [38] of interest are Benin, Burkina Faso, Burundi, Cameroon, Central African Republic, Chad, Comoros, Côte d'Ivoire, D. R. of the Congo, Djibouti, Eritrea, Ethiopia, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mozambique, Niger, Rwanda, Senegal, Sierra Leone, Somalia, Togo, Uganda, U. R. of Tanzania and Zimbabwe. In terms of employment in the Agricultural Sector, between 2000 and 2018, general employment numbers increased by 72.3% and employment numbers in Agriculture increased by 64.13% [39], [40] (fig.3). In contrast, in World Trend 2000-2018, general employment numbers increased by 25.8% and employment numbers in Agriculture decreased from 39% to 26% which raised the African LDCs Agricultural labor force participation from 12% to 22%. In the period 2000-2016 Agricultural Land increased by 19.82%, Cropland by 43.70%, Arable Land by 46.94% and Permanent Crops by 20.28% (fig. 4).

Figure 3 (up left), 4 (up right), 5 (down left), 6 (down right)

However, in terms of distribution of Agricultural Land, Cropland and Arable Land increased by only 4.4% and Permanent Crops remained static, while the ratio Permanent Crops/Cropland, 13.54% and 11.34%, is both small and declining [41], [42]. Still the figures showenormous potential for expansion [43].

While Exports/Imports dropped by 10% in the period 2005-2016, from 2005 at 66.13% to 56.45% in 2016, the balance deficit increased by 189% in the same period [44], [45] (fig. 5).Cereals are selected as the object of Agricultural Import [46] and are compared to Oil and Merchandise Imports (fig.6).

6. Conclusions

A new system, which promotes Agricultural Self-sufficiency by eliminating Agricultural Imports and at the same time decreases the trade deficit by using biofuel production as an intermediating mechanism, which decreases oil imports, was developed at first approximation. A partial application on African LDCs demonstrated that there is an objective for this system and further development and research is warranted.

7. References

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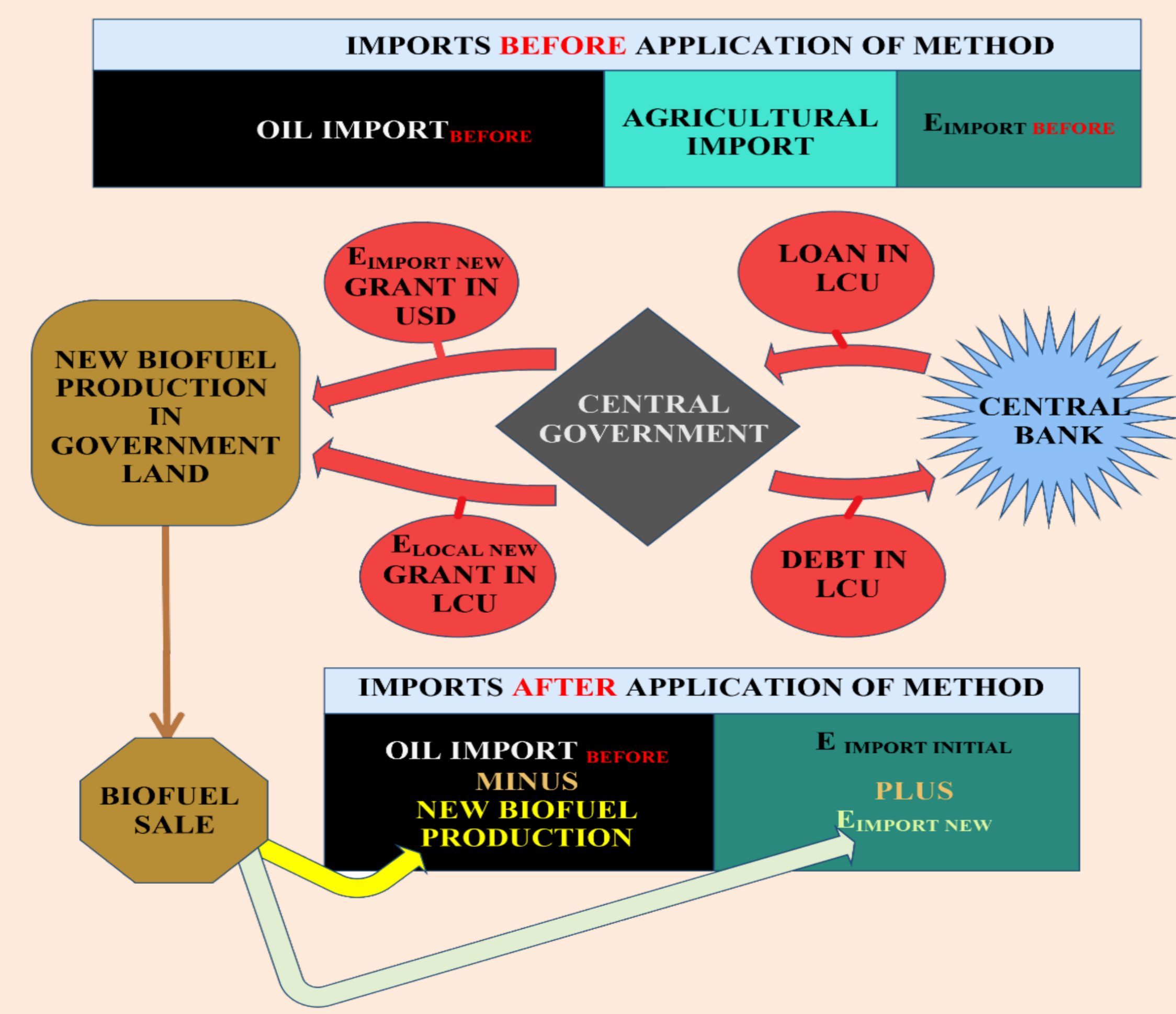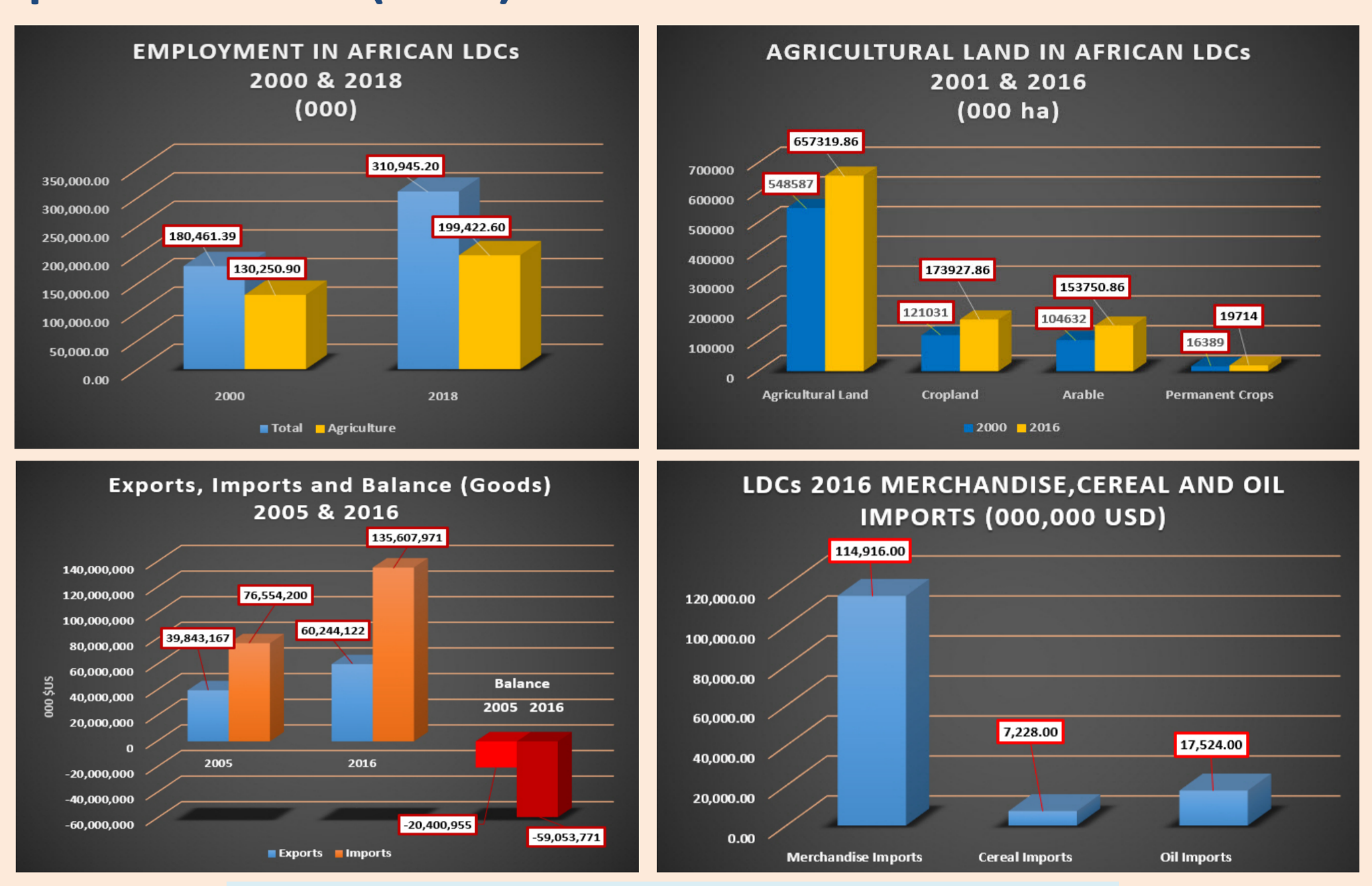## Notes

a. The term **X - M**, which is negative, is a component of GDP in expenditure form and for ease is written as - |X - M| so the GDP equation changes from Y = C + I + G - |X-M| to Y' = Y + ΔM i.e. nominally GDP increases.

b. The loan S0 may be covered by an issue of Narrow Money (M0) by the Central Bank, if the IMF allows it, which will be sequestered from circulation and therefore inflation is not influenced.

c. This method avoids the **"Dutch Disease"**, the real exchange rate and inflation distortions.