

## **The Sahel Problem**

by Hans-Werner Sinn

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HANS-WERNER SINN \*

### I. THE PROBLEM IN OUTLINE

The Sahel, one of the world's poorest regions, is a broad strip of Savanna on the southern edge of the Sahara. Its main countries are Mauretania, Senegal, Mali, Burkina Faso (Upper Volta), Nigeria and Chad: a broader definition would also include Sudan, Ethiopia and Somalia. According to FAO estimates, the region is not capable of feeding all the people who live there without some fundamental improvement in agricultural production (see *Fig. 1*). Compared to the Sahel, the regions that adjoin it to the south, particularly the countries on the Gulf of Guinea, are relatively prosperous and output there is large by African standards. A statistical estimate of the per capita income in these regions put it at three times that of the Sahel<sup>1</sup>.

The world at large became aware of the extent of the Sahel problem following the disastrous drought of 1968-1973, which in its last year alone took 100 000 human lives and reduced the livestock to a half<sup>2</sup>. But, however startling and dramatic this drought may have seemed, it

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1. In 1982 the average income of the narrowly defined Sahel countries was \$ 269, while that of the countries in the south – the Guinea countries (Benin, Ivory Coast, Zambia, Ghana, Guinea, Guinea Bissau, Cameroon, Liberia, Sierra Leone, Togo, Central African Republic) – was \$ 746. Calculated from World Bank [1984a, *Table 1*, p. 57].

2. Cf. SEN [1981].

was by no means an isolated occurrence. Erratic swings in climatic conditions are typical of the Sahel, periods of drought like the one mentioned tend to occur every 25 to 30 years and always claim their share of victims<sup>3</sup>. The wealth differential between the Guinea coast and the Sahel is a permanent phenomenon and the problems of the Sahel are chronic ones.

On the surface, the relatively low per capita income in the Sahel follows simply and directly from the unfavorable climate and the correspondingly low yields in agriculture. This explanation is, however, not entirely satisfactory for population density is also low. On average, the countries of the Sahel have a population density of around six to the square kilometer which is about one seventh of the average population density of their southern neighbours<sup>4</sup>. Yet, paradoxically, the Sahel ranks among the world's overpopulated regions!

Just as the relative poverty of the Sahel population cannot be explained simply as a result of the climate, so too it cannot be explained simply as a result of high birth rates. It is certainly true that the level of birth rates is significant for the development of West Africa as a whole, but, in relation to the Sahel problem, the birth rates effects are clearly dominated by the effects of migration between individual regions and countries. The extent of the migration may seem surprising to those used to the much more stable population structures in Europe. Experts, however, are quite familiar with this situation and it is discussed in numerous articles on the Sahel problem<sup>5</sup>.

It has been customary, at least from colonial times onward, for young men to work as seasonal laborers in the farms, plantations or factories in the south, or to take up employment there for longer periods. This custom arose partly as a result of head taxes imposed by the French. It has been estimated, for example, that up to 1.7 million

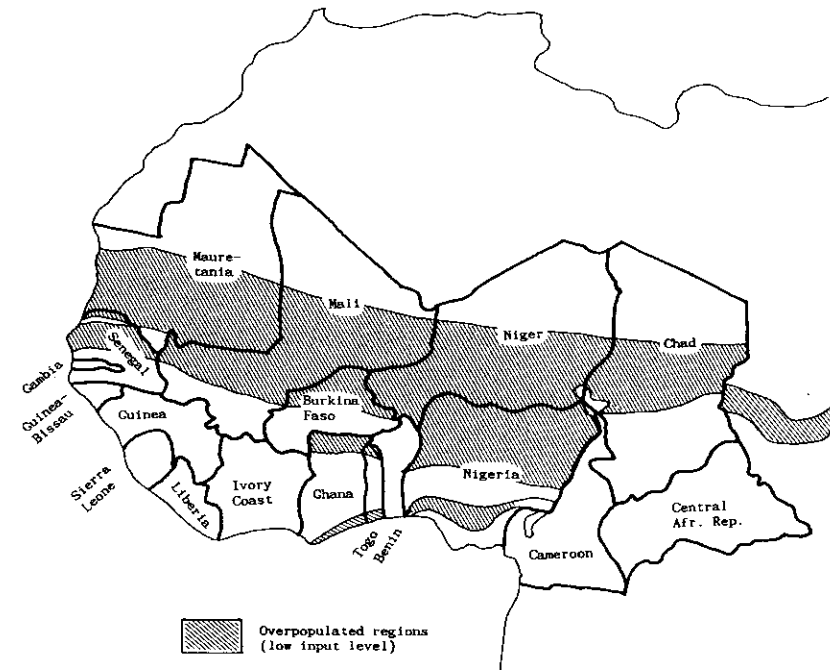
3. See KLAUS [1976].

4. These figures were calculated from World Bank [1984 a]. The countries referred to are those listed in footnote 1.

5. A very comprehensive overview of population movements in Africa is in CLARKE and KOSINSKI [1982], while AMSELLE [1976] contains an examination of motivations for such migrations. An informative overview of the historical migrations into Senegal is given in COLVIN [1981, pp. 68 n], cf. also REYNA and BOUQUET [1975] and MORRISON [1985, esp. p. 67].

Figure 1

Overpopulation in the Sahel



Source: FAO/UNFPA, [1980].

of the 6 million Burkina Faso nationals live permanently in the Ivory Coast<sup>6</sup> and that, of these, about half are employed in agriculture<sup>7</sup>. Many of these people settle down there and never return home again. As well, there are the migrations of the nomads and semi-nomads in Mauretania and Somalia who make up more than half the population. The nomads not only migrate annually within particular areas but sometimes also shift their migratory range to other areas. These

6. Cf. WOLFSON [1975, p. 99], GIRI [1983, pp. 44 n], FIELOUX [1980] or SCHIFFERS [1976, p. 9].

7. World Bank [1984 b, p. 101].

movements are in no way hindered by the new and not too firmly established national boundaries. Last, but not least, the vagaries of climate compel mobility. The 1968–1973 drought even drove farmers away from their ancestral lands, and many of those who were uprooted now earn their living as wage laborers in the south. Earlier droughts must have had similar mobilizing effects<sup>8</sup>.

The high level of mobility of the population of West Africa makes the north-south wealth differential in this area in the first instance a problem of population structure, that is, the distribution of a given population over alternative regions. Why didn't people spread over the area in a way that removed the differential? Why doesn't migration lead to an adjustment of per capita incomes, why does the Sahel remain poor?

Part of the answer to these questions could be that West Africa is at present going through a historical transition process and the adjustment in living standards is simply not yet complete. However, the high degree of population mobility, in view of the normal, regularly recurring, periods of drought, seems to require a more general, systematic, explanation. This paper attempts to provide one. The thesis suggested is that population movements cannot equalize the per capita incomes; that a wealth gap between north and south remains even when the migration process, unhindered by economic or political constraints, has led to an equilibrium in the structure of the population.

Formally, the model used to establish this thesis has some similarity to the dual-economy models of LEWIS [1954] and NURKSE [1957]. Judged by its economic content, however, it is more closely related to the literature on crowding externalities including GORDON's [1954] fishery model or the road congestion models of WALTERS [1961] and JOHNSON [1964]. In fact, it will be argued that the problem of the Sahel is a problem of crowding externalities.

If this view is correct, important implications arise for development policy in Africa, particularly with regard to the distribution of aid between the Sahel and the other regions. The main emphasis in this paper is on spelling out these implications. Even at this early stage

8. A good overview of the population flight from the Sahel after the 1968–1973 drought is found in SCHIFFERS [1978].

it can be said that current aid measures will not appear in a very favorable light.

## II. THE SAHEL PROBLEM: OVERPOPULATION OF A BORDER REGION

The phenomenon of production on land which is common property provides the basis for the explanation of the equilibrium wealth differential in West Africa. Agricultural areas in the Sahel are not owned by single households or families but are held in common. At best, a whole tribe may be able to claim certain property rights, but even in this case the conditions of ownership are mostly extremely unclear<sup>9</sup>.

The results of producing on common lands have been frequently deplored – this is the 'tragedy of the commons'. It has been pointed out that such production leads to a too large increase in the size of herds, with consequent overgrazing and desertification of large areas<sup>10</sup>. The problem of a shrinking supply of wood for fuel is also well known. Because most forests in the Sahel are held in common, the areas near the towns have become almost completely deforested as the result of unchecked felling of the trees. The bigger and the more permanent a settlement is, the bigger are the deforested areas. No firewood can be found for 50 miles around Ouagadougou, the capital of Burkina Faso, and a popular saying characterizing the situation is that it costs more to heat a cooking pot than to fill one<sup>11</sup>.

Villages and small settlements try to escape the fuel problem by choosing a radical solution: regular migration. Typically, when the supply of drinking water permits, the location of villages is changed every 10 to 15 years because of the shortage of wood and this means that the location of the fields is also changed<sup>12</sup>. The regular relocation of the fields is, in any case, typical of cultivation on savanna lands like those of the Sahel. A piece of land can only be cultivated for two or

9. See GIRI [1983, pp. 116, 270] and MAYER, BELAL and BÖS [1983, p. 300].

10. Cf. SEN [1984, pp. 127n], SCHIFFERS [1976, pp. 121n], or World Bank [1982, p. 66].

11. World Bank [1982, Box 6.1., p. 60].

12. SCHIFFERS [1976, pp. 130n].

three years before it becomes leached and, because the vegetation in the savanna regenerates only slowly, it can take 15 to 20 years before enough nutrients have been replaced in the soil to permit it to be recultivated<sup>13</sup>. Even agriculture is therefore not really settled and the land used by farmers, and not only that used by nomads, takes on the character of a common. It is clear that there is very little incentive for anyone to undertake the investment necessary to maintain the soil quality and that agricultural production cannot be other than extremely inefficient.

Although the inefficiencies resulting from production on commons with a given population have been adequately investigated, the influence that these inefficiencies have on the size of the Sahel population appears to be less well known. In this regard, it is important to note that the Guinea countries adjoining the Sahel to the south are only to a limited extent affected by the problem of the commons, if at all. First, there are hardly any nomads. Secondly, the Guinea countries have modern sectors with the usual attributes of market economies. Thirdly, and perhaps most importantly, favorable climatic conditions and the resulting ability of the soil there to regenerate quickly make the relocation of villages unnecessary<sup>14</sup>. The fallow periods are much shorter than in the north and far smaller areas of land are needed to maintain the desired levels of output. Under such conditions, extensive property rights in land could be established, access of migrants to cultivable land was restricted and the purchase, leasing and bequest of land became customary<sup>15</sup>.

Property rights in land must be defended and this requires the use of resources. Whether and to what extent property rights become established is therefore an economic question. The greater the concentration of resources, and the more regularly they are available, the shorter the boundaries of the area needed to ensure a given level of output and thus the lower the cost of defending the property rights.

13. Ibid., p. 174.

14. While the normal growth period in the Sahel as a whole is less than 150 days annually, in the northern part it is less than 75 days. In the Guinea countries a growth period of up to 300 days or more can be counted on. Cf. FAO/UNFPA [1980].

15. For a comprehensive picture of the way of life of a tribe in the Ivory Coast see LASSAILLY-JACOB [1983].

Property rights in land are therefore established in areas where the productivity of the land is high and certain; common ownership of land is unavoidable where yields are low and uncertain. This is the substance of DYSON-HUDSON and SMITH's [1978] territoriality theory. This theory, though originally developed from observations of North American Indian tribes, is also useful in explaining the differing degrees of territoriality in the Sahel strip and in the fertile Guinea Coast bordering it to the south.

Given these differences, the nature of the migration equilibrium between the two regions can easily be captured by means of a simple model. The area as a whole consists of two internally homogenous parts – the 'Sahel Zone' (SZ) with population S and the 'Guinea Coast' (GC) with population G. The total population B is given, and is spread over both regions:

$$B = S + G. \quad (1)$$

The regions produce the same good, with  $s(\cdot)$  and  $g(\cdot)$  standing for the appropriate partial production functions of labor, while Y measures total output:

$$Y \equiv s(S) + g(G). \quad (2)$$

The assumption of given, region specific, areas of land  $L_S$  and  $L_G$ , which enter into the expanded production functions  $s^*(S, L_S)$  and  $g^*(G, L_G)$ , is behind this formulation. These expanded production functions are assumed to be increasing, strictly quasi concave and linearly homogeneous<sup>16</sup>, implying, among other things, that the partial production functions have the properties  $s', g' > 0$  and  $s'', g'' < 0$ .

The property rights in land in the Guinea Coast are fully defined and a migrant must either work for wages or buy land from an existing owner. The wage rate  $w$  is equal to the marginal product of labor,

$$w = g', \quad (3)$$

16. The assumption of linear homogeneity is not used for the moment, but it simplifies the calculation of the elasticity of substitution between labor and land used in the next two sections.

because landowners demand labor up to the point where the last worker employed produces revenue equal to his cost. In the Sahel Zone on the other hand, property rights are not defined and the land there, which is freely available to all, cannot be sold. Anyone who remains in the Sahel receives the total amount he produces but if he leaves he gets nothing. There is therefore an incentive to migrate from the Sahel Zone to the Guinea Coast as long as the average product in the Sahel Zone is less than the wage rate in the Guinea Coast:

$$\frac{s(S)}{S} < w.$$

Conversely, when the average product in the Sahel Zone exceeds the wage rate in the Guinea Coast:

$$\frac{s(S)}{S} > w,$$

then migration in the other direction is worthwhile. Because  $s'' < 0$  implies that  $s(S)/S$  is a decreasing function of  $S$ , and because, conversely,  $g'' < 0$  together with (1) and (3) implies that  $\omega$  increases with  $S$ , a migration equilibrium with a stable distribution of the population results when  $\omega = s(S)/S$ ; that is, when the marginal product of labor in the Guinea Coast equals the average product of labor in the Sahel Zone:

$$g'(G) = \frac{s(S)}{S} \quad (\text{migration equilibrium}). \quad (4)$$

There is nothing special about the nature of this equilibrium, that is, the adjustment of marginal and average products or costs, for models with incompletely guaranteed property rights or external effects. There is a broad class of such models with similar equilibrium conditions that have been constructed to deal with other problems<sup>17</sup>. What is worth noting, however, is that (4) implicitly explains the income differential between the Guinea Coast and the Sahel Zone that was mentioned earlier. It holds, for all  $G > 0$ , that  $g(G)/G > g'(G)$  because  $g'' < 0$  and hence

17. Cf. the references given towards the end of Section I.

$$\frac{g(G^*)}{G^*} > \frac{s(S^*)}{S^*}, \quad (5)$$

with  $G^*$  and  $S^*$  standing for the equilibrium population structure determined by (1) and (4). Obviously, at equilibrium, the per capita income in the Sahel Zone is lower than in the Guinea Coast!

This result is illustrated in *Figure 2*, this figure will also be used for the subsequent discussion. The population of the Sahel is measured from left to right, that of the Guinea Coast from right to left and, accordingly, there are marginal and average product of labor curves sloping down from the left and from the right. Equilibrium is at the point of intersection L of the average product curve sloping downward from left to right and the marginal product curve sloping downward from right to left. This clearly implies a gap between the average products or per capita incomes of size XL.

It should be emphasized that the equilibrium obtained from (4) implies a welfare loss relative to the optimal population structure. Because of the way the diagram is constructed, the areas under the marginal product curves correspond to output levels in the two regions. Thus total output is maximized when the marginal products are equal:

$$s'(S) = g'(G) \quad (\text{output maximum}). \quad (6)$$

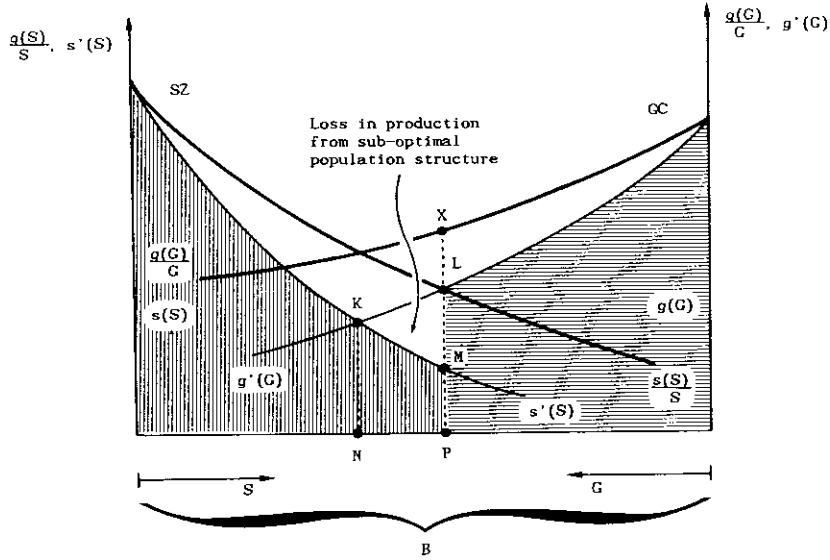
This condition is satisfied at point K. At migration equilibrium, however, the population in the Sahel Zone exceeds its optimal value by amount NP, while the population in the Guinea Coast is below its optimum by the same amount.

If, starting at the migration equilibrium, there were a movement of population of amount NP from the Sahel Zone to the Guinea Coast, output in the Sahel would fall by KMPN. This loss in output would be more than compensated though by the increase in output of KLPN in the Guinea Coast. The net increase in output or income as a result of the migration would be KLM.

Market forces would ensure that the maximum output described by (6) would be achieved if landowners in both regions employed labor only to an amount sufficient to maximize their ground rents. The output would then correspond to that of a von Thünen model. But rent maximization of the von Thünen type can only occur in the

Figure 2

Migration equilibrium between the Sahel Zone (SZ) and the Guinea Coast (GC)



Guinea Coast. Everyone in the Sahel has free access to any rents there and consequently these are competed away. That is the reason for the optimality condition not being met and for the resulting income differential.

The nature of the misallocation can be particularly well explained in the language of environmental theory. Someone who decides to migrate from the Guinea Coast to the Sahel produces no (Pareto relevant) external effects in the Guinea Coast. He loses income by an amount exactly equal to the reduction in output caused by his going away. However, when he arrives in the Sahel and begins to produce under the conditions prevailing there, he receives more than the change in output that he causes. Certainly, he can keep everything he produces directly, but his activity reduces the amount of output available to the population already there. This is so because he draws water from the same wells, puts his cattle on the same meadows, cultivates the same fields, and clears the same forests that the existing

population would have liked to use. Furthermore, he does not need to pay any compensation for the disadvantages his actions have brought to others. These disadvantages are negative external effects of his migration that do not enter into his decision. To the individual, migration into the Sahel is worthwhile even when it produces a collective loss, and an equilibrium will only be reached when the marginal individual benefit in the Sahel Zone equals the marginal social loss in the Guinea Coast. As mentioned earlier, the nature of this equilibrium is similar to that of a typical crowding externality model.

The word 'Sahel' comes from the Arabic and means 'coast' or 'border'. Indeed, the Sahel problem seems to be common to many regions bordering on deserts. Because resources are sparse, it is not worthwhile defining property rights, and because property rights are not defined, too many people are attracted into the area. It is true that absolute population density in these border areas is usually less than that of the more fertile areas, but, relative to the low production possibilities, it is nevertheless too high and per capita income is forced down below that of the more favored regions. Certainly, it is true to say that the per capita income in the border areas is low *because* the land is not very fertile, but the chain connecting cause and effect is by no means trivial. The problem of the commons is an important connecting link between cause and effect, without which the relative poverty of the border regions cannot be fully explained.

Traditionally the Alpine regions in Europe, with their large border zones between the desolate mountain peaks and the fertile valleys, were very poor. Today this poverty has been largely overcome but the reasons that it existed formerly are similar to those that explain the poverty of the Sahel. In the Alps too, the border regions were common property<sup>18</sup>. Although by the middle ages a well regulated system of ownership claims was in existence, these claims were not well developed enough to permit an emigrant to sell his capitalized share of the ground rent and take it away with him<sup>19</sup>. Thus he would have had to

18. The German word *Allmendewirtschaft* is used as a general term to describe production on common land although it originally referred to production in the *Allmende*, that is, common lands in Alpine regions. Even the word *Alp* itself characterized common property regions in mountain areas.

19. An extended description of *Allmendewirtschaft* can be found in BÜCHER

compare the wages he could earn elsewhere, not with the marginal product of his labor, but with its average product. There was no tendency towards the removal of the income differential between the Alpine regions and those in the more fertile parts of middle Europe, where the institution of private property had been an early development.

A further example that shows the effects of labor migration and common property resources particularly clearly is the relative poverty that traditionally exists in fishery regions<sup>20</sup>. Although here it is not low resource density but rather technical difficulties that are responsible for the lack of property rights in fishing, the migration equilibrium follows the general pattern. Provided that the share of capital in production could be neglected, a tendency showed up for the average product of labor in fishing to be equal to the marginal product of labor in agricultural production in the areas away from the coast. Here, too, a difference in per capita incomes prevailed<sup>21</sup>.

### III. AID FOR THE SAHEL

Since the great drought there has been a continuous flow of official international aid to the Sahel. Approximately half of this consists of direct developmental aid from different OECD countries, a quarter comes from international financial institutions like the World Bank or the European Development Bank, just under 20 % comes from

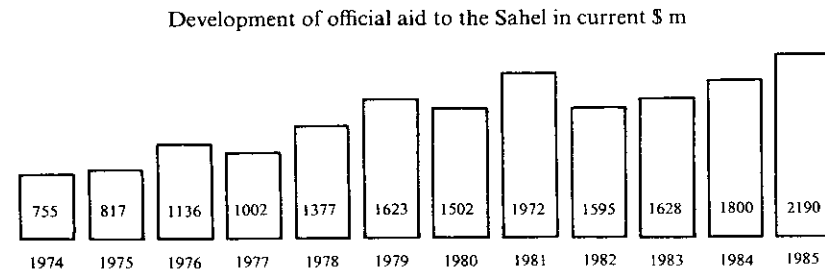
[1909]. Only in exceptional cases was it possible to sell a claim to the *Allmende*, or to maintain a claim after emigration.

20. See MALTHUS [1803, book II, ch.I, p.16], for an early description of the poverty of fishermen relative to farmers in Norway. MALTHUS did not consider the migration problem though. He attributed the observed differences in per capita wealth and population density to different attitudes towards birth control which he explained, in turn, by systematic differences in the perception of resource scarcity in farming and fishing.

21. This is a direct implication of the equilibrium described in the relevant fishery models in which the price of fish corresponds to the average cost of catching it and not to the marginal cost. Cf. GORDON [1954].

OPEC and 5 % from the United Nations<sup>22</sup>. *Figure 3* shows how this aid developed over time. The figures do not include donations from private organizations which are in any case comparatively insignificant. Aid was \$ 44 per head in 1981 which was more than twice the average amount of aid given to other African countries (\$ 20).

Figure 3



Source: GIRI [1983, p. 282] and World Bank [1987, Tab. 21]

Today, aid to the Sahel is no longer regarded as an unexpected subsidy, designed to overcome a sudden emergency, rather it has become a regular, completely expected, source of income. This aid is, without any doubt, very significant in making the Sahel region attractive to migrants and it is to be expected that it will exercise a strong influence on the population structure of West Africa in the long run.

The nature of this influence can be made clear by means of a simple model<sup>23</sup>. With H standing for the flow of aid to the Sahel, the migration equilibrium is now given by

$$\frac{s(S) + H}{S} = g'(G) \tag{7}$$

22. See GIRI [1983, p. 282].

23. All aid is modelled as simple food donations. This assumption is for simplicity and it also adds to the clarity of the formulation. The basic conclusions of the model are not essentially changed, if, for example, aid is included as a factor in the production functions.



instead of by (4). The differentiation of this equation, taking (1) into account and with  $B = \text{constant}$ , gives

$$\frac{dS}{dH} = -\frac{1}{s' - g' + Sg''} \quad (8)$$

With

$$\alpha_G \equiv g' \frac{G}{g}, \quad 0 < \alpha_G < 1, \quad (9)$$

and

$$\alpha_S \equiv s' \frac{S}{s}, \quad 0 < \alpha_S < 1, \quad (10)$$

as partial production elasticities of labor in the Guinea Coast and the Sahel Zone, and<sup>24</sup>

$$\sigma \equiv -\frac{(1 - \alpha_G)g'}{g''G} > 0 \quad (11)$$

as the Hicksian substitution elasticity between labor and land in the Guinea Coast, the expression<sup>25</sup>

$$\frac{dS}{dH} = \frac{1}{\frac{s}{S} \left[ 1 - \alpha_S + \frac{(1 - \alpha_G) S}{\sigma G} \right]} > 0 \quad (12)$$

is obtained from (8). This expression and all following expressions are based on the assumption of a 'small' overall level of aid, or, technically speaking, on the assumption that all derivatives refer to the point where

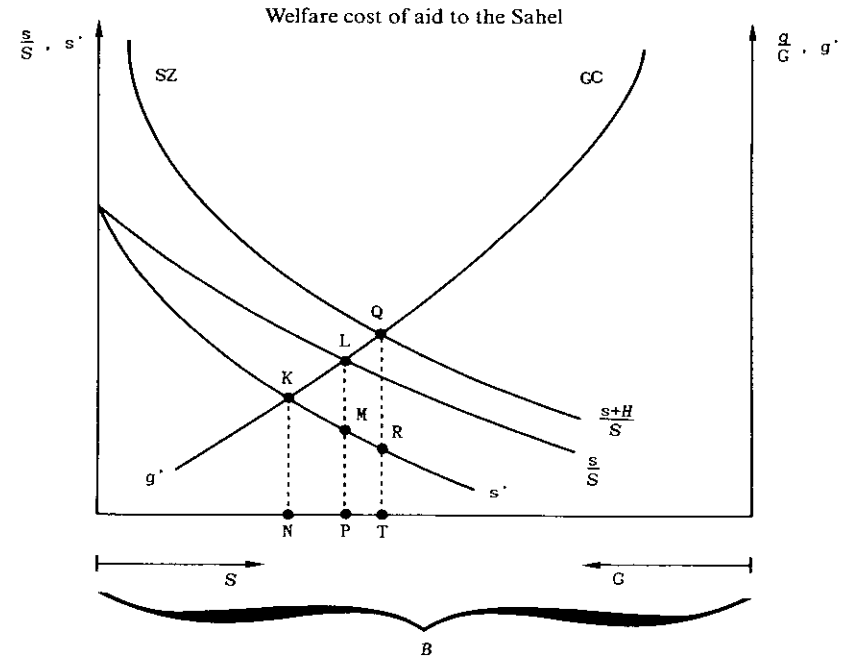
$H = 0$  and accordingly  $s/S = g'$  from (7).

24. In accordance with the assumptions of Section II,  $g(G) \equiv g^*(G, L_G)$  holds, with  $g^*$  a linearly homogeneous production function and  $L_G$  the fixed stock of land in the Guinea Coast. It follows that  $\partial g^*/\partial G = g'$ ,  $\partial g^*/\partial L_G = (g - g'G)/L_G$  and  $\partial^2 g^*/(\partial G \partial L_G) = -g''G/L_G$ . If these derivatives are inserted into the Hicksian substitution elasticity  $\sigma \equiv (\partial g^*/\partial G)(\partial g^*/\partial L_G)/[g \partial^2 g^*/(\partial G \partial L_G)]$  - cf. KRELLE [1969, p. 108, equation (5.5 II b)] - and (10) is used, the expression given in (12) follows.

25. If both sides of equation (13) are multiplied by  $s/S$ , an elasticity is obtained which gives the relative change in the population of the Sahel, resulting from the relative increase in income, that the aid measures would produce with a given population. This modification will not be taken up here, for (13) enters directly into the formula for the calculation of the welfare effect.

Because,  $s, S, G, \sigma > 0$  and  $\alpha_S, \alpha_G < 1$ , it follows from (12) that aid leads to a comparative increase in population in the Sahel area. Plausibly, this effect is stronger, the lower the existing per capita income in the Sahel Zone ( $s/S$ ) and the smaller the Sahel population ( $S$ ) are compared to the Guinea Coast ( $G$ ). The strength of this effect, however, also depends on the characteristics of the production technologies. The larger the partial production elasticities of labor in the two areas ( $\alpha_S$  and  $\alpha_G$ ) and the bigger the substitution elasticities between labor and land in the Guinea Coast ( $\sigma$ ), the bigger the technological scope for changes in the employment of labor and the larger the migration.

Figure 4:



Migration into the overpopulated Sahel area, or, what amounts to the same thing, a halt to emigration that would otherwise take place, is an extremely adverse, unavoidable, effect of the aid measures. The

overall level of output in West Africa is in any case too small because of the common property problem; aid-induced migration makes it even smaller. *Figure 4* shows this clearly. The aid measures induce a movement from the original equilibrium point L to a new point Q. As a result, a population shift from the Guinea Coast to the Sahel of size PT occurs and, while output in the Guinea Coast falls by LQTP, output in the Sahel only rises by MRTP. The initial welfare loss KLM will therefore be increased by the area LQRM.

An important question here is how big the additional loss of output is. Differentiating (2), using (1), (7), (10) and (13), after a few transformations the following is obtained for low values of H:

$$\begin{aligned} \frac{dY}{dH} &= \frac{dY}{dS} \frac{dS}{dH} \\ &= (s' - g') \frac{dS}{dH} \\ &= - \frac{1}{1 + \frac{1 - \alpha_G}{1 - \alpha_S} \frac{1}{\sigma} \frac{S}{G}} < 0. \end{aligned} \quad (13)$$

As was to be expected, this expression is negative and shows an output loss. The same qualitative effect on the size of this loss as on the strength of the migration effect in (12) is exercised by  $\alpha_G$ ,  $\sigma$ , S, and G. Only the partial production elasticity of labor in the Sahel Zone,  $\alpha_S$ , has changed its role. *Ceteris paribus*, a high value for this elasticity implies that the average product of labor curve is flat, and thus there will be a strong migration effect. However, by definition, such a value means a high value of the marginal product of labor in the Sahel compared to the average product there, that is, only a small difference between the marginal products of labor in the two regions. This explains why the size of the output loss has an inverse relationship to the size of the partial production elasticity in the Sahel Zone.

It is worth noting that (13) obviously implies

$$\frac{dY}{dH} > -1 \quad (14)$$

This shows that, although the two regions taken as a whole suffer a loss because of the migration, the reduction in aggregate output is always smaller than the amount of aid. Thus a net income increase remains.

However, this net increase in income can be very small. It follows from (13) that

$$\frac{dY}{dH} \rightarrow -1 \text{ when } \frac{S}{G} \rightarrow 0. \quad (15)$$

This means that the exacerbation of the population misallocation eats up practically the whole of the aid when the Sahel is a 'small country' and when the resulting migration does not lead to a change in real wages in the 'big country'; that is, the Guinea Coast.

The assumption of the 'small country' is somewhat of an exaggeration but the population of the Sahel Zone is by no means large. In 1982 the population of the Sahel was 32 m. and that of the Guinea countries was 133 m. so that  $S/G = 0.24$ <sup>26</sup>. If, for example, the production functions in the two regions were the same and were of the Cobb-Douglas type ( $\alpha_S = \alpha_G$ ,  $\sigma = 1$ ), with such a value of S/G, (13) would indicate an output loss still amounting to 81 % of the aid. This is an order of magnitude that places serious doubts on the value of such aid.

The size of the welfare loss may at first sight seem surprising, but it is no longer so when it is considered that the migration caused (or prevented) by the aid intensifies a misallocation that already exists (or that otherwise would have occurred). It is well known from the theory of taxation that the size of the excess burden is not a linear, but a progressively increasing, function of the departure from the optimum as measured by the gap between the two marginal products of labor. This effect is clearly apparent in the present case and explains why aid can cause such a large loss of output.

26. Cf. World Bank [1984a]: the 'Guinea countries' are those listed in footnote 1 (including the Central African Republic).

IV. ASSISTANCE TO THE GUINEA COAST

Instead of giving assistance directly to the Sahel Zone, transferring the scheduled amount of aid to the Guinea Coast countries could be considered as an alternative. In contrast to (4) or (7), the long run migration equilibrium is then given by

$$\frac{s(S)}{S} = g'(G) + \frac{\bar{H}}{G} \tag{16}$$

with  $\bar{H}$  standing for the aid going to benefit the inhabitants of the Guinea Coast.

Point Q in Figure 5 represents the new equilibrium. Compared to the migration equilibrium without aid, L, it shows an emigration from the Sahel to the Guinea Coast of size TP. The migration increases total output in the two regions by the area VLMR, which represents the net effect of a reduction in output in the Sahel of RMPT and an increase in output in the Guinea Coast of VLPT.

A few calculations are again necessary to get a better idea of the order of magnitude of the effect. First, differentiating (17) with respect to (1) where  $H = 0$ , gives the expression

$$\frac{dG}{d\bar{H}} = \frac{1}{(g' - s') \frac{G}{S} - g' G}$$

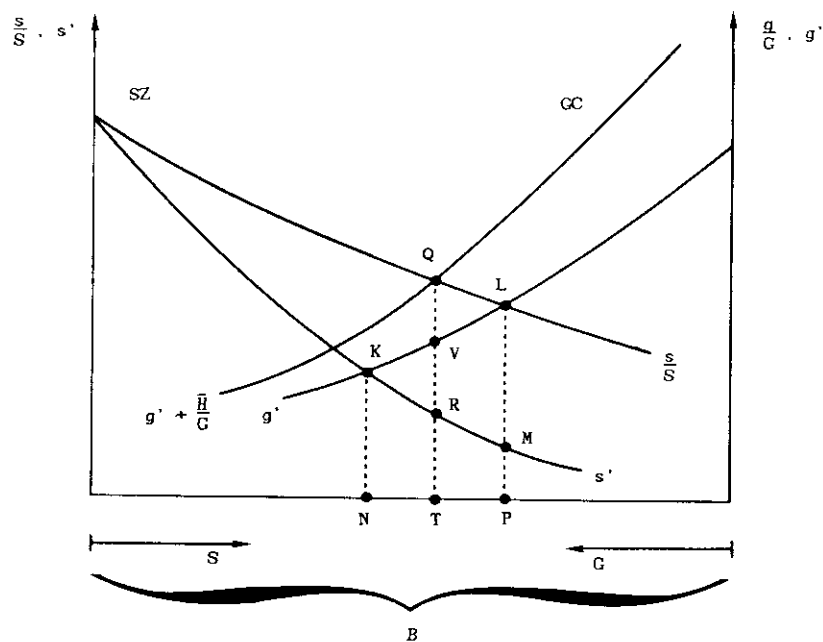
from which, using definitions (9)-(11) and once more (17),

$$\frac{dG}{d\bar{H}} = \frac{1}{\frac{s}{S} \left[ (1 - \alpha_s) \frac{G}{S} + (1 - \alpha_G) \frac{1}{\sigma} \right]} > 0 \tag{17}$$

is obtained. This equation describes the effect on migration to the Guinea Coast and shows that the strength of this effect is dependent on the same variables as the migration to the Sahel in (12), which results from the aid made available there. The population variables S and G, however, have changed their roles in this case. Thus, the effect

Figure 5

Aid to the Guinea Coast: indirect aid for the Sahel



of migration resulting from a given amount of aid generally proves to be the stronger the smaller the area receiving aid and the larger the area receiving none.

The effect of aid on the aggregate level of production, as with (13) and using equations (1), (2), (7), (10) and (17), is given by

$$\begin{aligned} \frac{dY}{d\bar{H}} &= \frac{dY}{dG} \frac{dG}{d\bar{H}} \\ &= (g' - s') \frac{dG}{d\bar{H}} \\ &= \frac{1}{\frac{G}{S} + \frac{1 - \alpha_G}{1 - \alpha_s} \frac{1}{\sigma}} > 0. \end{aligned} \tag{18}$$

As was to be expected, this expression shows a rise in output. The variables  $G$ ,  $S$ ,  $\alpha_G$  and  $\sigma$  have the same effects qualitatively as in (17), but  $\alpha_S$  works in the opposite direction for the reasons already explained in connection with (13).

It is worth noting that, compared to (13), the change in output induced by a unit of aid has, in principle, no upper limit. This follows from the fact that (18) implies

$$\frac{dY}{dH} \rightarrow \frac{\sigma(1 - \alpha_S)}{1 - \alpha_G} \text{ when } \frac{G}{S} \rightarrow 0. \quad (19)$$

Thus, when only a small part of the population lives in the area with well defined property rights while by far the largest part lives in the area where property is held in common, when the partial production elasticities of labor are similar ( $\alpha_S \approx \alpha_G$ ) and when the substitution elasticity between land and labor in the Guinea Coast exceeds unity ( $\sigma > 1$ ), then it is possible for the increase in output to exceed the amount of aid.

This interesting theoretical case is, however, probably not very relevant for the Sahel problem. For the example  $\sigma = 1$  and  $\alpha_G = \alpha_S$ , dealt with at the end of the last section, and the actual population size given there, which implies  $G/S = 4.16$ , (18) predicts an increase in output of only about 19% of the aid.

Compared to the reduction in output that results when aid is given to the Sahel, this is not much. Nevertheless, if the aid now flowing to the Sahel were reduced, and the funds thus freed were redirected to the Guinea Coast, the result would undoubtedly be a large increase in output. In general, for such a policy of reshuffling the aid,

$$\left(\frac{dY}{dH} - \frac{dY}{dH}\right) \Delta H = \frac{1 + \frac{S}{G}}{1 + \frac{1 - \alpha_G}{1 - \alpha_S} \frac{1}{\sigma} \frac{S}{G}} \Delta H \quad (20)$$

is obtained from (13) and (18). For the special case  $\alpha_G = \alpha_S$ ,  $\sigma = 1$ , it follows that total output in West Africa rises by an amount exactly equal to the volume of redirected funds.

Note that the conclusion from (20) is completely independent of the initial population structure ( $S/G$ ). Only the same technologies and a substitution elasticity equal to one are required. Obviously, for any values of  $S/G$  in the range  $0 < S/G < \infty$ , it holds generally that

$$\frac{dY}{dH} - \frac{dY}{dH} \begin{cases} > \\ = \\ < \end{cases} 1 \Leftrightarrow \sigma \begin{cases} > \\ = \\ < \end{cases} \frac{1 - \alpha_G}{1 - \alpha_S}. \quad (21)$$

Whether the increase in output is greater than, equal to, or smaller than the amount of the redistribution depends, therefore, only on how big  $\sigma$  is relative to  $\alpha_G$  and  $\alpha_S$ . Because the underlying expanded production functions  $s^*$  and  $g^*$  are linearly homogeneous,  $1 - \alpha_G$  and  $1 - \alpha_S$  can be interpreted as partial production elasticities of land in both regions<sup>27</sup>. The expression (22) thus means, for example, that the transfer of aid from the Sahel Zone to the Guinea Coast will, in the long run, raise total output in the two regions taken as a whole by more than the amount of redistribution when the substitution elasticity between land and labor in the Guinea Coast is greater than the ratio of the partial production elasticities of land in the Guinea Coast and the Sahel. There is, a priori, no reason for dismissing this case as implausible.

#### V. DIRECT OR INDIRECT ASSISTANCE: WHICH BENEFITS THE POPULATION OF THE SAHEL MOST?

It is certainly instructive to discover how the output of the two areas as a whole is affected by the different arrangements. However, those whose main concern is with the poverty of the Sahel will not find this procedure satisfactory. They will, in a Rawlsian manner, focus exclusively on the lot of the poorest, and appeal for aid to be distributed in a way that raises the living standard in the Sahel as much as possible. What can be said to these people? Is it obvious that, given this aim, all aid should go directly to the Sahel or is indirect aid through payments

27. Compare the explanation following equation (2).

made to the Guinea Coast also a possibility? After all, such aid would bring about a rise in the per capita income in the Sahel too, because it induces emigration from there.

Just guessing, it might appear that, from the point of view of raising living standards in the Sahel, direct aid must necessarily be better than indirect. But it should not be forgotten that, unlike direct aid, indirect aid raises total output and thus increases the scope for redistribution. It is therefore not obvious that indirect aid is of less use to the people of the Sahel.

This question, too, can be answered by means of the model described. The variable  $x$  stands for per capita income, including aid, in the Sahel. According to (7) and (16), it then holds generally that

$$x = \frac{s(S) + H}{S} = g'(G) + \frac{\bar{H}}{G}. \quad (22)$$

Differentiating this expression with respect to  $H$  at  $H = \bar{H} = 0$  gives, using (1),

$$\frac{dx}{dH} = \frac{dx}{dS} \frac{dS}{dH} = -g''(G) \frac{dS}{dH}$$

and taking account of (11) and (12) one obtains:

$$\frac{dx}{dH} = \frac{1}{G \frac{\sigma(1-\alpha_s)}{1-\alpha_G} + S} > 0. \quad (23)$$

Analogously, differentiating (22) with respect to  $\bar{H}$  gives

$$\frac{dx}{d\bar{H}} = \frac{d\left[\frac{s(S)}{S}\right]}{dG} \frac{dG}{d\bar{H}} = \frac{-s'S + s}{S^2} \frac{dG}{d\bar{H}},$$

from which, after inserting (17) and using (10),

$$\frac{dx}{d\bar{H}} = \frac{1}{G + \frac{1-\alpha_G}{(1-\alpha_s)\sigma} S} > 0 \quad (24)$$

can be calculated.

No good arguments for direct aid to the Sahel emerge from a comparison of (23) and (24), even when overall welfare in West Africa is not considered and the focus is entirely on living conditions in the Sahel. For example, there is no difference at all between (23) and (24) in the case of Cobb-Douglas technologies ( $\alpha_s = \alpha_G, \sigma = 1$ ). Here,  $dx/dH = dx/d\bar{H} = 1/(S + G)$ , which means that the per capita income in the Sahel is rising by an amount which is independent of where the aid goes. The distribution of the increase in income is exactly the same as when the aid is spread evenly over the population of West Africa and migration is excluded. But naturally migration into the area that receives aid does, in fact, occur. It is just because of this migration that, in this example, the population of the Sahel benefits from aid given to the Guinea Coast to the same extent as when aid is given directly.

In general, it follows from (23) and (24) that

$$\frac{dx}{dH} \begin{cases} < \\ = \\ > \end{cases} \frac{dx}{d\bar{H}} \Leftrightarrow \sigma \begin{cases} > \\ = \\ < \end{cases} \frac{1-\alpha_G}{1-\alpha_s}. \quad (25)$$

As with (21), this expression gives a decisive role to the substitution elasticity and the partial production elasticities. If the substitution elasticity between land and labor in the Guinea Coast is greater than the ratio of the partial production elasticities of land there and in the Sahel, a transfer of aid from the Sahel to the Guinea Coast not only leads to an increase in total output of more than the amount of aid transferred, but it can even be expected to raise the living standards of the people of the Sahel, who initially seemed to be at a disadvantage!

#### VI. CONCLUDING REMARKS: REAL AID TO THE SAHEL

The argument in this paper is that the Sahel problem is a general one that applies to border regions between deserts and fertile areas. Because resources are sparse, property rights do not develop in these regions, and, as a result, more people immigrate than is sensible in view of the low productive capacity of the land.

In the final analysis, the solution to the problem is not to pump resources into the border region, for this will make the already ineffi-

cient population distribution even worse. Consideration should be given to whether assistance should also go to the fertile region, and, if so, whether it should receive the lion's share of the aid. Doing this would not only raise output in aggregate, but could be worth recommending as being in the long run interests of the border region.

Naturally this would require continuing migration like that of the past decades, unhindered by the development of nation states. If this does not happen, the migration effect can only take place within countries and the policy recommendations stemming from the model would be to give assistance in the first instance to regions with well developed property rights within a country.

In a somewhat different connection, similar views appear to be held by the official aid organizations. The World Bank, especially, has recently preferred to support areas with good resource bases and developed infrastructures, and has praised those governments that have resisted pressure to let aid, or a large share of it, go to the climatically disadvantaged parts of their countries<sup>28</sup>. Certainly, this position is based not so much on population movement as on other more obvious economic conditions. Nevertheless, this World Bank policy can be regarded as appropriate for the problem of the population structure studied in this paper.

Unfortunately past development policies were not always so sensible. On the one hand, as mentioned before, the Sahel was given far more aid per capita than the other African countries and, on the other, part of this aid was given not directly in the form of food, but for questionable projects like digging deeper wells that everyone had access to. It is well known that the problem of the commons was thereby made more acute and, in the areas where the wells were dug, the desert has encroached even further<sup>29</sup>.

Real help for the Sahel requires attacking causes of poverty, not the symptoms and must take into account the relevant economic mechanisms that influence the population distribution. It would be ideal if ways and means could be found to set up guaranteed property rights in land in the Sahel at a reasonable cost. To overstate the case – in

stead of bread, perhaps what is needed is barbed wire to help protect the property rights. Well defined property rights would eliminate the main cause of poverty and then, hopefully, agricultural efficiency would improve and the remaining income disparities would be reduced. Then, despite its unfavorable climate, the Sahel would cease to be the Almshouse of Africa.

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28. World Bank [1981, esp. pp. 52 n].

29. Cf. SCHIFFERS and co-workers [1976, pp. 122 n]; CALDWELL [1975, pp. 42 n]; EL-FOULY [1975, 54].

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## SUMMARY

The Sahel is a border region between desert and fertile land. Because of the low density of resources, property rights cannot be established and, because of the missing property rights, there is overcrowding: population is high relative to the resource base. The crowding externalities involve welfare losses that, with free migration, will be exacerbated by direct aid. Replacing direct aid with indirect aid given to the neighbouring fertile regions will not only reduce the welfare losses; under mild technological conditions this measure will, in the long run, increase the aggregate production volume of all regions by more than the amount of the aid and will even improve the standard of living in the Sahel.

## ZUSAMMENFASSUNG

Der Sahel ist eine Grenzregion zwischen Wüsten und fruchtbarem Land. Wegen der geringen Ressourcendichte können in solchen Grenzregionen keine Eigentumsrechte etabliert werden, und wegen der fehlenden Eigentumsrechte sammeln sich dort relativ zur Ressourcenbasis zu viele Menschen. Die Übervölkerung hat Wohlfahrtseinbußen für Westafrika in seiner Gesamtheit zur Folge, die bei freier Wanderung durch einseitige Hilfe an den Sahel nur noch verstärkt werden. Ein Ersatz der zur Zeit gewährten direkten Hilfe durch eine indirekte Hilfe, die an die fruchtbaren Nachbarregionen geleistet wird, würde zu einer Verbesserung der Bevölkerungsallokation führen, die nicht nur die Wohlfahrtseinbußen verringert, sondern unter schwachen technologischen Bedingungen auf lange Sicht die Gesamtproduktion Westafrikas um mehr als das Umschichtungsvolumen erhöhen und sogar den Lebensstandard der Sahelbevölkerung selbst verbessern kann.

## RÉSUMÉ

Le Sahel est une région frontrière, entre le désert et les terres fertiles. A cause de la densité peu élevée des ressources, des droits de propriété ne peuvent pas être établis et, à cause de ce manque de droits de propriété, il y a une densité excessive de population comparée aux ressources. Ces externalités d'encombrement impliquent des pertes de bien-être qui, avec une migration libre, sont exacerbées par une aide directe. Le remplacement de l'aide directe par une aide indirecte, qui serait donnée aux régions fertiles avoisinantes, non seulement réduirait les pertes de bien-être mais, dans des conditions technologiques relativement générales, il augmenterait le volume de la production totale de toutes les régions plus que par le volume du remplacement lui-même et il améliorerait même le niveau de vie du Sahel.