Deutscher Tropentag 2000 in Hohenheim
Session: Overcoming stresses in crop production: 1. Weeds and insects

New approaches in the assessment of desert locust management in Africa

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Abstract

Desert locusts are considered to be an important threat to crop production in the semi-arid areas extending from Western Africa to India. Being a trans-boundary public bad, they made the governments of affected countries intervene with emergency control operations mostly using chemical pesticides. Although the most recent FAO-study concludes that control is uneconomical, the view that desert locust control tallies up with improving food security prevails among decision-makers in affected countries, who still stick to a state-run control strategy. This paper reviews and identifies advanced economic concepts capable of integrating the dimensions of the desert locust problem going beyond the control philosophy of previous approaches. The presented methodology is capable of incorporating a broad range of effects into the economic evaluation and is applicable to different loss abatement strategies.

Keywords: desert locust, locust control, migratory pests, economic evaluation

1 Introduction

Since ancient times, the desert locust has been considered an important threat to crop production in the semi-arid areas extending from Western and Northern Africa over the Arab peninsula to Pakistan and India. Due to their ability to form huge, mobile swarms in their gregarious phase and their feeding on all varieties and parts of plants, their sudden appearance in farmers' fields is a fear-instilling event. The perception of this pest as a major threat to agricultural yields has led the governments of affected countries to engage in emergency control operations with chemical pesticides. Currently, FAO has the mandate to coordinate and implement a control strategy that aims at early intervention to prevent the develop-

ment of swarming populations by monitoring and control operations in the remote breeding habitats of the desert locust. Global expenditures for desert locust control exceeded US$ 500 million between 1989 and 1998 (Joffe, 1998). Donor contributions to control operations have exceeded US$ 300 million in the 1986-1989 campaign alone (Schroeder, 1999).

In spite of the considerable investments, in-depth economic evaluations of control campaigns remain scarce. A more recent FAO-study based on a bio-economic simulation model developed from historical and expert data estimated the likelihood of positive net benefits from the conventional control strategy in the range of 10 to 20 percent. Although external costs of pesticide use like production losses in livestock and environmental damage were not included in the analysis, negative average net benefits were estimated at US$ -10 to -23 million per annum (Joffe, 1998). Notwithstanding these results, the view that desert locust control tallies up with improving food security prevails among decision-makers in affected countries. As a consequence, governments, international organizations and bilateral donors stick to a state-run strategy often claiming to protect the most vulnerable from food insecurity.

This paper reviews and identifies advanced economic concepts capable of integrating the dimensions of the desert locust problem that go beyond the control philosophy of previous approaches. A framework for an economic evaluation of desert locust management is developed that makes the decision process more transparent and places emphasis on the farm level situation. The research is based on the hypothesis that previous analyses are built on a problematic reference system that tends to overestimate benefits of the control strategy.

2 Economic issues of the desert locust problem

2.1 The public bad issue

Desert locusts were early recognized as a 'public pest' or – in economic terms – a public bad, which calls for control before the destructive

swarms reach the farmers' fields (Kremer, 1992). Claims for public intervention were implicitly based on the assumption that farmers could not protect themselves at a reasonable cost (Krall, 1995; Houndekon and Groote, 1998). Conversely, government control can be considered as a public good. It is therefore implemented by state-run institutions and financed from the government budget and donor contributions. Due to the huge migration area, preventive control is moreover a public good on the international level. The current control strategy is based on the hypothesis that monitoring and timely, targeted control in the remote breeding habitats is the least cost strategy for protecting cropped land. As a consequence, countries with important breeding areas are considered priority intervention sites, even if their own agricultural production is not exposed to high risk like in Mauritania. On the other hand, e.g. Morocco has a major stake in effective control on Mauritania’s territory, since the latter is the major source of swarms invading the country. Hence, bilateral side payments occur and international organizations play a coordinating role in implementing preventive control activities.

Due to the public goods character of the natural and human resources affected by the control activities, external costs of pesticide application, which may affect farmers but also e.g. bee and livestock keepers, bystanders or consumers occur. Hence, the assessment of control interventions calls for a comprehensive cost-benefit analytical approach which is capable to capture these effects.

2.2 Risk issues

On average, desert locust plagues occur only in one year out of six (Joffe, 1995) and decision-makers perceive the risk of losses such that they are ready to incur negative net benefits of -10 to -23 million US$ annually to insure against the possible damage. It is doubtful if such a risk premium is justified on an aggregated level. Figure 1 shows above average cereal production during the plague year 1988 in Sudan. This indicates either that on a national level there is no substantial damage even in plague years or that effective control prevented high losses in

1988. Unfortunately, the efficacy of control measures is only rarely examined or recorded so that a final conclusion is impossible.

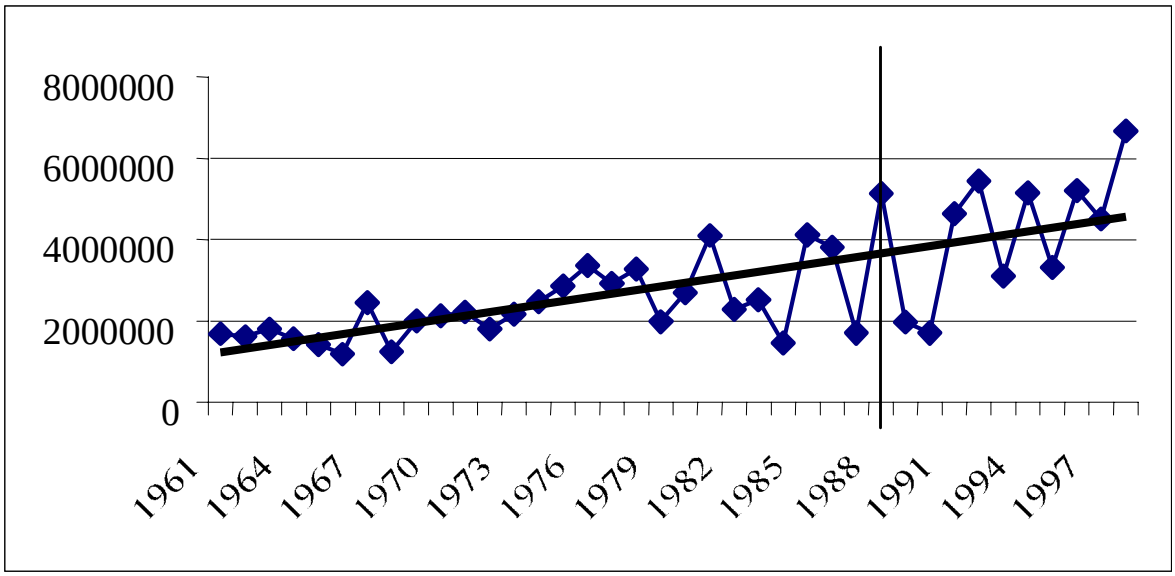

Figure 1: Cereal production in Sudan (metric tonnes). Plague year 1988.
Source: (Belhaj, 2000)

From the viewpoint of the individual farm, the likelihood of an invasion by desert locust swarms is usually very low, while the effects of an invasion may threaten the livelihood of the farmer's family (Krall, 1995). As preventive control is imperfect, individual farmers have strong incentives to engage in coping and mitigation strategies to reduce the risk of income losses. A survey in Niger has shown that farmers are very well aware of the imminent threat although their experience of actual invasions is at most anecdotal (Krall 1994). Contingent valuation surveys on the willingness to pay for desert locust insurance conducted in Morocco and Sudan obtained an annual willingness to pay of US$ 8 to 21 per head (Belhaj, 2000). Apart from these studies, analyses have largely failed to include farm level data and no case studies exist on coping and mitigation strategies of farmers.

3 Economic evaluation

3.1 Reference system

Cost Benefit Analysis is the apt tool for the evaluation of public intervention options from a welfare theoretical point of view and constitutes the basis of the framework. It measures the incremental contribution of a planned intervention to social welfare against a reference scenario. Defining a sound reference system, however, is crucial and in the plant protection sector often a critical task (Waibel, 1990).

Table 1: Decision matrix for a public decision-maker.

		Payoffs		
State of nature	**p**	a_1 Control intervention	a_2 No control	a_3 Insurance
s_1: Recession year	0.8	490	490	495
s_2: Plague year	0.2	488	460	465
Expected value		489.6	484	489

Table 1 illustrates the decision situation of a public decision maker using hypothetical data. The *potential yield loss* is frequently cited to demonstrate the scale of a pest problem (Steedman, 1990; Krall, 1994; Joffe, 1995; Krall, 1997). It amounts to the difference in yield under recession and plague conditions, respectively, when no control is undertaken. It is, however, irrelevant for choosing an intervention strategy, because it does not include the payoffs of the available alternatives. The relevant criterion for decision-makers on the public level is the net expected value of a strategy[1]. Then, losses only occur when a sub-optimal strategy is chosen and economic loss is the difference between the net benefits of the best and second best strategy, respectively (Waibel, 1990). In the example, the economic loss of refraining from control in favor of the insurance solution amounts then only to 0.6, which is substantially less than the potential loss.

[1] Where a substantial share of the national income is at risk or risks are positively correlated, a risk premium might be subtracted as proposed by Anderson JR, J.L. D (1992) Risk Analysis in Dryland farming Systems. FAO, Rome. In fact, public decision makers were found to be extremely risk averse Joffe SR (1998) Economic and policy issues in Desert Locust management: a preliminary analysis. .

Furthermore, it is important to account for the coping and mitigation strategies farmers choose under a given desert locust risk. Hence, a two-fold decision has to be considered. First, the public intervention strategy is chosen and then farmers will react to the perceived desert locust risk with their own adaptation strategies. Farm level data are hence a constituent component of the here proposed analytical scheme **(Figure 2**). The scheme is capable of considering a diversity of alternative public intervention strategies including insurance as a non-technical, economic instrument.

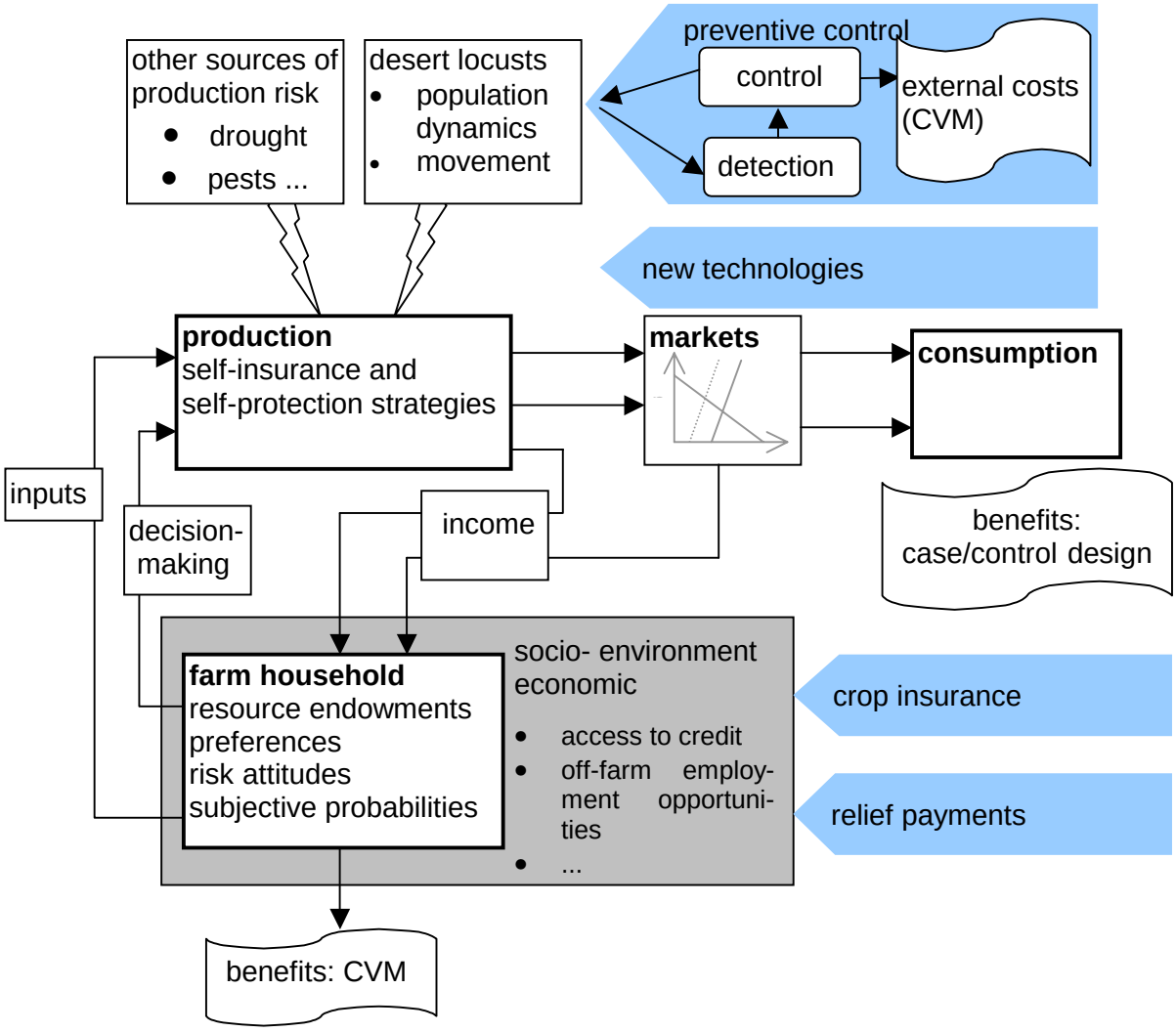

Figure 2: A simplified model of the evaluation framework.

3.2 Farm level analysis

The assessment of intervention strategies has to be based on actual farm level data that reflect the farmers' reaction to the perceived desert locust risk. As farmers are likely to be risk averse (Binswanger, 1980; Anderson and Dillon, 1992), their reaction to any public intervention affecting the risk will lead to an adaptation of on farm coping strategies. These would have to be analyzed in a risk analytical framework. Contrary to a public decision maker, farmers are expected to maximize their expected utility, i.e. the certainty equivalent of the available strategies. A case/control design seems most appropriate to measure the farmers' reaction to the prevailing public strategy. The utility derived from an insurance can be obtained using the contingent valuation method (see e.g. Belhaj, 2000) while stochastic income data can be obtained from farmers with the visual impact method (Hardaker *et al.,* 1997).

3.3 Project or program level

To obtain a measure of the economic feasibility of a locust control farm level data and direct project costs have to be aggregated and valued at shadow prices according to established procedures (Gittinger, 1982; Mishan, 1994). Besides that, external costs, which are expected to be substantial especially in the case of pesticide use, have to be included in the project account. A variety of methods is available to measure the value of the environmental effects mentioned for preventive control in **Figure 3**.

Even when rigorous quantitative data on external effects are lacking, estimates of the costs can be obtained from contingent valuation studies among the affected stakeholders. E.g. livestock productivity losses caused by pesticide application on pastures can be acquired by asking for the pastoralists willingness to pay for stopping the use of hazardous pesticides. This would also clarify if the presumption holds that also livestock keepers benefit from locust control.

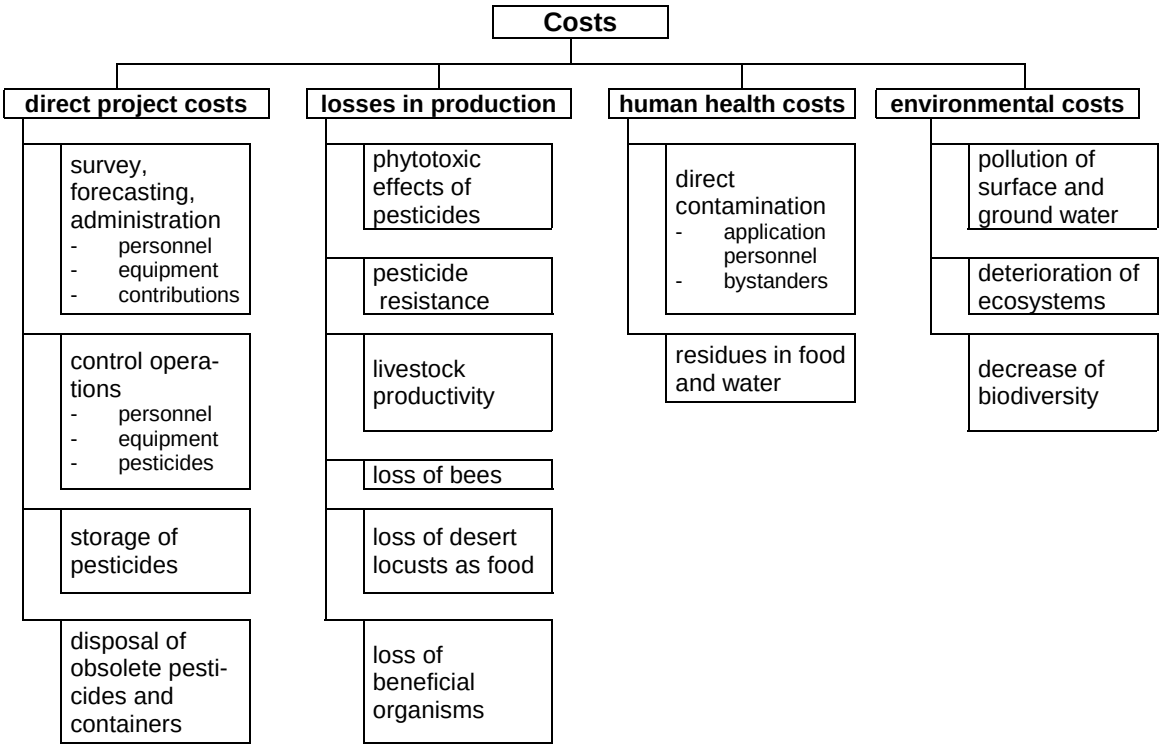

Figure 3: Cost categories of pesticide use in desert locust control.

It is moreover proposed to calculate the project summary criteria as stochastic values by incorporating parameters as stochastic variables in a Monte-Carlo simulation taking the covariate relationship of important components into account (Figure 4).

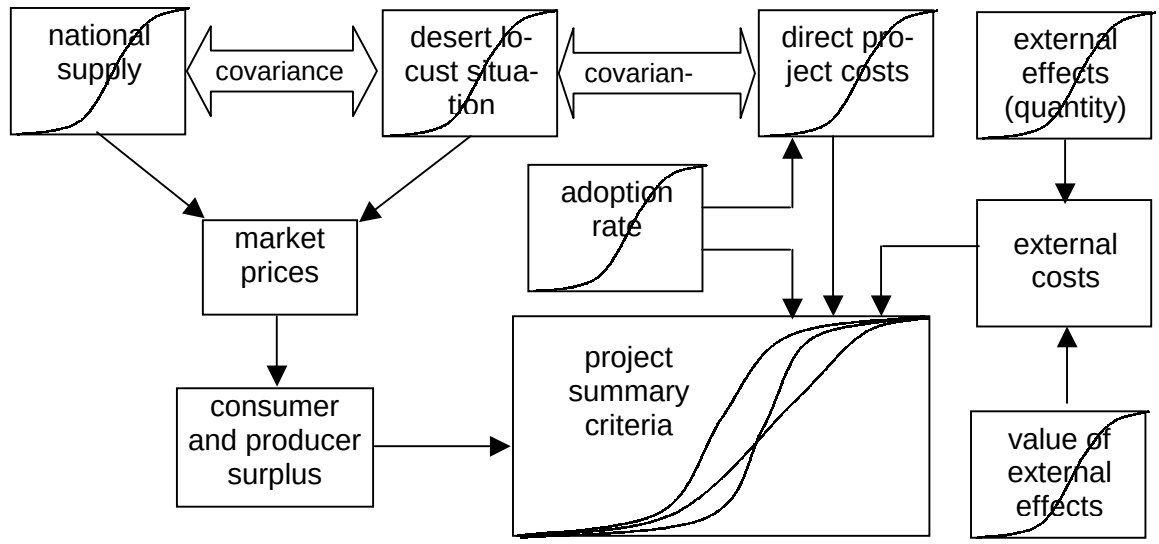

Figure 4: Uncertain project benefit and cost components

This procedure will yield cumulative distribution functions e.g. of the net present values of the considered strategies for comparison according to stochastic dominance criteria. Decision makers are hence forced to disclose their risk attitudes which adds to the transparency in decision-making. Even for risk neutral decision makers, the consideration of presumably covariate factors like e.g. desert locust damage and overall national supply would influence the estimation of economic ramifications of supply shocks (Herok and Krall, 1995; Belhaj, 2000).

3.4 International coordination

The scope of CBA is restricted to one country in order to obtain relevant decision criteria for national decision-makers. However, the migratory nature of the desert locust makes it an international phenomenon. Actually, the preventive control strategy is based on the hypothesis that it is most effective to control the locusts in their breeding locations before they reach agricultural lands. The problem can, therefore, be treated analogously to international pollution problems (see e.g. Hanley*, et al.*, 1997). Two parameters influence the profitability of an intervention strategy: the uniformity of damage and the uniformity of mixing. The former refers to the fact that damage potential of one unit of the international externality varies for different countries. As a consequence, the benefits derived from control will differ among affected countries depending e.g. on the cropping systems, geographic and socio-economic factors. In Figure 5, this would show up in different marginal damage curves MDC_j. Uniformity of mixing, on the other hand, relates to the contribution of one country's efforts to control the locust to the overall desert locust population. This will again differ according to the geographic location, climatic conditions and the type of control strategy.

As a consequence, the cost of control of one unit of desert locusts will differ among countries, which is reflected in different marginal abatement cost curves MAC_j. When countries optimize their level of control, they equate marginal damage costs and marginal abatement cost at Q_n, which is the non-cooperative outcome or *Nash Equilibrium*. If countries

could agree to cooperate for control, the sum of marginal damage costs would be equated to the individual countries' marginal abatement costs at Q_c to attain a higher level of control. However, countries with lower marginal damage cost have to be compensated to make them participate in the strategy.

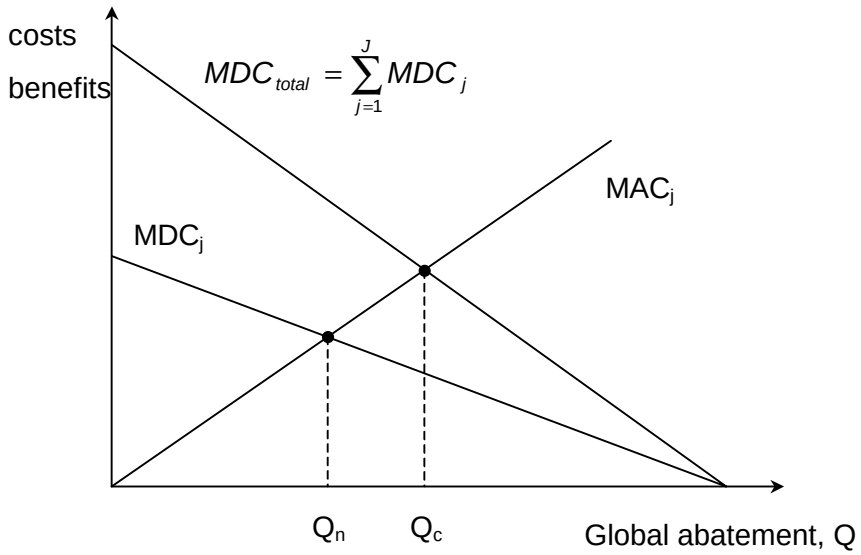

Figure 5: Non-cooperative and full cooperative outcomes of preventive desert locust control (adapted from Hanley*, et al.*, 1997,p. 167)

4 Conclusions

When a sound risk analytical framework is applied and externalities are taken into account it becomes obvious that the reference system on which previous studies were based tends to overestimate the net benefits. The framework developed here is able to compare the efficiency of different intervention strategies and proposes to take alternative intervention options into account. As the proposed framework refrains from the previously predominant modeling approaches, the implementation of the concept requires a no-control site as a counterfactual for comparison. This task can be solved using areas where control actions were not carried out due to reasons like lack of funding, armed conflict or resistance from inhabitants.

Analyses based on this framework are expected to provide a relevant basis for decision making and to contribute to a transparent decision proc-

ess. The sometimes emotional and often inappropriate debate on desert locust control should be replaced by sound decision-making with the goal of ensuring the efficient allocation of development funds.

5 References

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