Madura was the focus of the Sixth International Workshop on Indonesian Studies held in October 1991 at theKITLV. Anthropologists, historians, musicologists, Islamologists, rural economists, and students of ecology met to address the topic 'Madurese culture: continuity and change'. The selected workshop papers in this volume testify to the growing and diverse scholarly interest in Madura, which until a few decades ago attracted relatively little academic attention.

The topics range from the legitimacy of kingship in the seventeenth and eighteenth centuries to the history of the Negara Madura during the Indonesian Revolution; and from the pre-war South Seas expeditions by the musicologist Fahnstock to present-day dramatic and musical expression. Other authors deal with the role of religious leadership and mystical brotherhoods, outsiders' stereotypes of the Madurese, and the ecology of the island. With respect to the present-day economic situation, authors address the consequences of industrialization and of building a bridge connecting Madura with Java.

A number of the authors conducted their fieldwork in Indonesia in the framework of the Madura Research Programme under the aegis of the Cultural Agreement between Indonesia and the Netherlands.

The editors of this volume were the conveners of the workshop: Kees van Dijk, affiliated with the KITLV; Huub de Jonge, Senior Lecturer in the Department of Anthropology at the Catholic University in Nijmegen; and Elly Touwen-Bouwsma, head of the Indonesian department at the Netherlands Institute of War Documentation.
ACROSS MADURA STRAIT
THE DYNAMICS OF AN INSULAR SOCIETY

Edited by
Kees van Dijk, Huub de Jonge and Elly Touwen-Bouwsma

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GLENN SMITH

Madurese maize and bovines seen through an ecological-materialist lens

Introduction

The last two decades have seen a wealth of new research dealing with Madurese culture and society, spurred by the Dutch-Indonesian Madura Research Project. While many particular aspects of Madurese culture have now received authoritative description and study, a number of researchers have sought to identify what general principles, if any, govern Madurese culture or certain features thereof. Ecology has provided some of them a framework for modelling key aspects of the cultural responses to conditions found in Madura. The present contribution seeks to delineate an ecological-materialist framework I believe could accommodate a larger proportion of the ethnographic data we currently possess on Madurese culture and society in what could be a fruitful dialogue between field research data and general ecological concepts.

The value of ecology for studies in Madura has been noted elsewhere, earlier, and by others. Leunissen used an ecological perspective in his village study of Manding Daya which dealt ‘almost exclusively with the way in which the community described provides for itself’ (Leunissen 1982:208). Kuntowijoyo (1980) suggested that the main contours of Madurese social organization and religious expression were moulded by ecological scarcity leading to ‘individual-centred’ social relations on an island characterized by a tegal (dry field) ecosystem.

My approach calls for a more literal translation of theories belonging to the discipline of natural ecology into the concepts of cultural ecology used in anthropological analysis (Smith 1989). Where Kuntowijoyo emphasizes ecology (‘ecological scarcity’ in the Madura case) as primary causal factor, and Leunissen employs ecology as a heuristic descriptive tool, I view ecology as providing a systems model for cultural study. Much practice, action, belief

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1 I am indebted to Sigma Phi of Berkeley, California and Sigma Xi, the Scientific Research Society of New Haven, Connecticut, for their grant support and to the Lembaga Ilmu Pengetahuan Indonesia (LIFI) for providing institutional sponsorship for my fieldwork in Madura from September 1985 to February 1987.
- in a word, culture - results from sets of causes and effects which interact in what could be described as a systems model, similar to an ecological systems model. While Leunissen sees ‘the main virtue’ of the ‘ecological-anthropological approach’ lying in its descriptive rather than ‘explanatory power’ (Leunissen 1982:208), my approach seeks to, however tentatively, identify and evaluate causal factors. Indeed, any system is by definition a causal model in which causal forces must be identified and their direction and weight determined. The cultural materialist approach places strategic priority on determining the material constraints communities must overcome, and predicts that the most significant causal forces governing cultural continuity and change will usually be identified within productive and reproductive processes. An essential assumption of this approach is that people, on the whole, will give priority to attempting to overcome these material constraints, in the process selecting for cultural elements that aid these efforts. It is suggested that with the help of such an approach ecology can be a more valuable guiding principle for anthropological work, especially useful in development studies and planning where decisions must be made between alternative modes of resource or development aid allocation.

Devising tools for an explanatory anthropology of Madurese culture is thus more than simply an academic pursuit; these tools can perhaps be used to forge a better image for the Madurese themselves. They are often characterized by outsiders and in the popular press as brutal and unreformed, with the phenomenon of carok duels portrayed as a model of their behaviour. Madurese peasants, like their counterparts in other so-called ‘backward’ regions of Indonesia, are criticized for their inability or unwillingness to adapt to modern forms of agriculture, animal husbandry, sanitation, or conflict resolution. Too frequently, the Madurese are chastised for one or another moral failure due to some aspect of their culture, perceived as primarily governed by a specific mentality or constellation of values. I prefer a less restrictive definition of culture to encompass not only ideology but also practices, behaviour, and institutions. Significantly, various explanations of Madurese culture imply corresponding policy responses. If, in fact, Madurese mentality is responsible for the insecurity, underdevelopment, and poverty characteristic of many Madurese areas, the implication would be that more effective government extension and educational services are needed in the villages. On the other hand, if ecological, economic or technical considerations lie at the root of the problems, their resolution would require that measures be taken to address a different set of needs, one which may include the provision of infrastructures, credit facilities, and welfare assistance.

Preliminary briefings on Madurese culture and, quite often, its shortcomings, are sometimes offered by officials at the national, provincial, district, and subdistrict levels. Madurese love for their maize and their cattle were two topics I often found myself discussing in these bureaus. These traits will be considered below in the light of material factors with the aim of grounding them within the particular ecological, economic, and social environment in which Madurese must operate their farms and families. The focus will be on microfoundations, since any ‘credible hypothesis about explanatory social regularities’ depends on ‘at least an approximate idea of the underlying mechanisms at the individual level’ (Little 1991:196). I will argue that these cultural traits, which are often explained by taste, conservatism or values, can be effectively accounted for by material considerations at the individual and community levels. Though I will limit myself here to these two agricultural topics, it could be suggested that material factors play important roles in other Madurese cultural traits, such as the propensity to migrate or to on occasion settle disputes through duelling (carok).

The ecology of grain selection

In 1986 and 1987, the local agricultural extension officer (Penyuluh Pertanian Lapangan, or PPL) in Batuputh (Sumenep) was working on a plan that would transform the agricultural system of this hill area. The goal was to introduce a high-yielding maize variety in pure stands that would eventually replace the indigenous maize varieties and the beans (soybean, green gram) intercropped in association with them. Improved varieties accounting for about half of the maize planted in the widely irrigated areas of the Sumenep District (Lenteng, Ganding, and Guluk-Guluk), the time had come to focus more attention on agricultural development in poorer areas such as Batuputh.

Yields from native varieties of maize are low in comparison to those obtained from improved varieties. A typical hectare of traditional maize yields anywhere from under 1 ton to 2.5 tons, depending significantly on fertilizer application. On at least one field located in a favourable location in the south of the subdistrict, the PPL claimed a yield of 3 tons per hectare, but most peasants, particularly those in the dry hilly areas extending to the north coast, receive yields situated at the low end of the range. On the other hand, yields of 3 to almost 5 tons/ha are common for the improved Arjuna and Abimanyu varieties planted in Madurese soil, and 6 tons/ha has been achieved in Java.

2 The plot received 125 kg of urea and 90 kg of TSP (trisodium phosphate) per hectare. The PPL calculated the overall yield by extrapolating the dry weight of grain harvested from a small area of the plot.
3 Four Arjuna demonstration parcels planted in 1985 within irrigated perimeters in Madura yielded 3.8 t/ha, 4.5 t/ha, 4.7 t/ha and 4.9 t/ha (measurements based on cut maize allowing for 15% humidity; see Groundwater Development Consultants 1986). Arjuna remains in the
Despite the impressive performance of these new varieties, convincing peasants to try them out was no easy matter. By early 1987, only two peasants were willing to turn over a portion of their fields for demonstration plots. During his attempts to enlist peasants, the PPL frequently mentioned his disappointment with what he saw as the ‘traditionalist’ nature of the Madurese, irrationally holding on to their native maize even if it meant continued poverty.

He saw Madurese food preference as both the cause and the way out of the predicament. It was widely acknowledged that the native variety was more flavourful than the improved variety. Yet, the PPL pointed out that the Madurese who switch to the new variety would have such improved yields that if they were to sell the entire harvest they could afford to consume rice exclusively, rather than as a prized supplement to be added to meals when available means permitted. Since most people stated a preference for rice over maize, the PPL felt he had a strong argument with which to win over peasants to the plan, reasoning that food preferences would determine participation in the plan. As we know, however, food preferences do not necessarily determine use (Rozin 1987) nor by extension do they always govern planting practices.

Whether they could go on eating their tasty corn or switch to rice was probably among the lesser concerns of the average Batuputhi peasant contemplating the project. In 1986-1987, all peasants in marginal areas (comprising the vast majority of Batuputhi’s territory) were convinced that the new variety could not grow well in their soil. They noted that whereas the native drought-resistant strain was sometimes imperilled by late or insufficient rains, the new variety would be at even greater risk. Those living in the many areas plagued by shallow soil depth would have to prepare mounds to accommodate the deeper-rooting improved varieties. Though grain production might increase, less biomass would result since the bean crops would have to go. This would endanger animal husbandry which, as elsewhere in Madura, depends heavily on crop residues.

Though the existing systems could be criticized, they had one key advantage, their diversity. The mixed-cropping systems found in many parts of Madura provide a high degree of diversity as they integrate cultivation of several different food crops and animal husbandry, thus lessening dependency on any one component of the system. If maize production was low one season, for example, the peasant could cut losses with a good bean harvest and by making full use of crop residues as cattle fodder. This fail-safe system could not be discarded lightly.

Far from dependent on extension services for their agricultural knowledge, Batuputhi peasants reasoned using a diachronic view of their habitat’s potential and comparative information on high-yielding varieties planted elsewhere nearby. Though few peasants were aware of the long-term aims of the Agriculture Ministry, they could perhaps guess that any change to monocropping of a high-yielding variety would entail an overhauling of their agricultural system, one with attendant risks they could ill afford to take.

Here it is significant to note the positive link between ‘diversity’ (or the related term ‘complexity’) and ‘stability’ hypothesized for ecological systems (MacArthur 1955; Margalef 1968). Though contested by some scholars of natural ecology (May 1974; Watt 1968) and in need of further field studies and more precise definition of terms (Real and Levin 1991:187-8), the proposition that diverse or complex ecological systems tend to be more stable has nonetheless been seen to apply to productive interaction in human communities. Stability can be a product of multihabitat resource redistribution systems (Abruzzi 1989) or, similar to the case in Batuputhi, it can be improved by increasing the number of resources clusters that are exploited in a single habitat (Vondal 1987:48-9). Simply stated, the diversity of resource flows from maize, beans, fodder, and other crops provides improved stability over a system based entirely on maize monocropping. Further research on the diversity-stability question could conceivably come from more research on human communities, where measurements of stability or community welfare are possible, and in some cases (Abruzzi 1989) available in historical records.

The maize project had been abandoned by the time I returned to Batuputhi in November 1990. Long-term tests had conclusively proved the new varieties unadapted to the soil and water conditions of the highland area. The plants, when able to anchor themselves in the shallow soil, produced only a few grains per cob. Heavy rain or wind would frequently blow the plants over.

The local peasants were thus right to have adopted a ‘wait and see’ attitude. They also demonstrated their ability to appreciate the web of interacting variables inherent in a shift in agricultural strategy, one which could entail trading a low-production system that works for a high-production system with hidden costs that might not work at all. As for the question of food preferences, one might venture that a preference for ‘sweet’ indigenous corn, ‘improved’ corn, or rice could not have influenced a decision between the two varieties of maize unless it were to mediate between equally attractive agricultural options.

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4 Average topsoil depth for the Batuputhi Subdistrict is 8 cm to 10 cm.
The beginnings of a new awareness are perceptible among development officials that local knowledge is not necessarily composed of irrational traditions and tastes. There are hopeful signs that the orientation of agricultural development may be responding to accumulating evidence that marginal areas and indigenous planting practices merit more study and consideration.5

Bull-racing and the cattle system

Anyone familiar with Madurese village life is aware of the importance of animal husbandry. An ecological systems model or ecosystem approach can be applied to the relationship between animals, including large ruminants such as Madura cattle, vegetation, and peasant communities (Onded’hal 1972; Ravindranath et al. 1981; Reddy 1981). In such analyses, ruminants play an important role in permitting humans to exploit additional energy circuits within an ecosystem by transforming vegetation of little or no direct benefit to humans into accessible energy in the form of traction, dung, meat, and other products.

A host of conditions on Madura have contributed to enhancing the value of cattle beyond that usually found in peasant societies.6 Animal husbandry provides supplemental income to crop farming, returns from which are often insufficient for subsistence due to the small size of family farms, low soil fertility, and the difficulty of developing irrigation systems over most of the island. In some cases, the income from cattle husbandry alone can exceed that received from planting crops. Madurese cattle would be nearly priceless were their value determined solely by the care heaped on them. A time allocation study of 37 families carried out in a village of northeastern Madura showed that adult (14 and over) women spend 16.5% of their time between the hours of 6 a.m. and 6 p.m. tending to their animals (mainly gathering cut green fodder for cattle) while adult men spend 13.5% of their time at this activity.7 For adult women, only food preparation takes up more of their time (17.7%), whereas for the men, only wage labour (16.0%) and garden labour (14.7%) are more time-consuming. Girls and boys between the ages of 6 and 13 spend, respectively, 13.5% and 5.3% of their time caring for

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5 The recent opening of a centre for the study of dry land farming systems, located between Kamal and Bangkal, is one welcome development on this score.

6 The characteristics of the Madura breed of cattle have been described by several authors, among them Kok (1921), National Research Council (1983), Payne and Rollinson (1976), Popenescu and Smith (1988), and Sommerfield (1923).

7 This study, the preliminary results of which were presented in Smith (1989), was carried out over a one-year period from February 1986 to February 1987 using the random spot-check or ‘instantaneous scan’ sampling technique. For a justification of this technique and a discussion of time allocation methods in general, see Gross (1984).
animals. For these children, tending to the animals is their most important activity outside of school.

The dearth of wage employment and other income-earning activities, and the low returns of those which do exist, only partly explains why almost every family raises cattle in the villages, whatever the cost may be to household labour. Climate, notably the unpredictability of rainfall, provides a decisive argument for owning one's own cattle. Peasants who neither own their own pair of plough animals nor guard cattle for others are at a great disadvantage, for at the critical moments when ploughing is possible they must await their turn to borrow from others or else pay for a plough team and driver. Renting is expensive and any borrowing must usually be paid back in one way or another. Is rainfall so unpredictable? As a general rule of thumb, grasses used for cattle fodder cannot maintain their growth when there is less than 64 millimetres of rainfall in a given month, and this situation arises from two to five consecutive months per year on the average (Payne 1973). The recording of rainfall by the Batuputh Subdistrict is incomplete, but a look at rainfall figures between 1976 and 1990 (excluding 1979 and 1980, for which measurements were not taken) illustrates the great variability from year to year and month to month in terms of total rainfall, rainy days per month, and dry spells between rains. In some normally wet months, only two days of rain occur. Under these conditions, rapid ploughing within one or two days if not hours following an adequate rainfall can make the difference between a successful and a failed planting in rainfall-dependent fields.

Besides the imperative in drought-prone areas of having access to cattle, and their investment value, cattle produce dung that is carefully collected and applied as fertilizer, and can pull carts, though cart racing is becoming a rare sight these days. Last but not least, some cattle become the pride of their masters by taking part in bull-races (kerrabhan sapè) or cow beauty and agility contests (sapè sono).  

Though cow contests are rare and in any case seem to have been a recent colonial invention, bull-racing is found all over the island of Madura. Few other world cultures race bulls on a regular basis, though horses are raced in many cultures. Given the difficulty of controlling even 'domesticated' bulls, the development of kerrabhan sapè is one of the puzzles of Madurese culture, especially when we consider that horses long present on the island could have been raced instead. My hypothesis is that bull-racing became popular rather than horse-racing since the former could play a vital role in the existing system of animal husbandry based on household farms. To begin with, male and female cattle are differentially valued depending on the ecological and economic context. In East Madura, the strong overall preference for female cattle can in some areas and in some periods endanger the selection and breeding of males vital to community livestock reproduction. To support my argument, it is necessary to go back to the discussion of agricultural conditions in the areas where bull-racing likely developed.

The soils encountered in dry fields in the Sumenep District, as in Batuputi, are not particularly heavy. Rainfall is necessary more for preparing a moist support for seed germination than for its aid in breaking up the soil. In most areas of Sumenep, female cattle are perfectly able to plough the soil, indeed they are preferred for several reasons. A particularity of the breed, Madura cattle are rather high-strung and need constant human presence to reinforce their domestication. Females, however, are somewhat easier to control during ploughing, almost the only time they are removed from the stable. Female cattle consume less feed than males, an appreciable difference when all fodder must be gathered by people. Finally, females produce calves, ideally at the rate of one per year. Calves provide replacements for aged or sickly plough animals or important supplements to the household budget if sold. The main benefits of male cattle, increased draught power and the ability to gain weight rapidly, are not needed in a village environment lacking hard-packed soils, abundant fodder resources, and a large market for beef. Closer to the large slaughterhouses of Surabaya and Java, and having a slightly better availability of dry season fodder due to higher levels of precipitation, the western districts of the island can support limited fattening operations for the male cattle sold out of the Sumenep District. In Sumenep, there are 4.9 cows for every male (the highest female to male ratio in East Java), while in Pamekasan, Sampang, and Bangkalan there are, respectively, 2.5, 2.0 and 2.2 cows per male (Biro Pusat Statistik 1985). The preference for cows is most pronounced in the east, but I would suspect that elsewhere on the island many peasant households prefer to raise cows, outside of those which receive male cattle transiting or undergoing fattening in the west before export to Java.

Could this marked preference for female cattle result in a shortage of breeding stock? Though it is difficult to determine the precise ratio of female to male cattle that must be maintained for optimum reproduction in cattle systems lacking modern techniques, it is safe to say that the stability and improvement of a community's livestock depends on its ability to encourage the selection and raising of a pool of breeder bulls which can pass along the traits so sought after among Madura cattle, namely high heat tolerance, feed frugality and efficiency, endurance, and agility. The practice of castration has never developed in Madura, perhaps an indication of widespread and chronic shortage of bulls in the past.

Dispersed residential patterns common to Madura require a larger pool of
breeder bulls than would be needed were settlements grouped together. The difficulty is that individual peasants raising bulls in an environment clearly favouring the raising of cows do not benefit nearly as much as do other members of the community who can simply borrow their males. The owner (or guardian) must take care of the bull, cut more grass and carry more water than would be necessary for a cow, struggle to plough with the bull, and forgo calves from it. Conceivably, it was pressure to find a way to solve this dilemma that led so many communities to adopt the bull-races. If the sport had adaptive value, contributing to community production as well as social and sporting diversion, it stood a greater chance of being widely adopted, regardless of how the practice originated in the first place. Certainly it would have had little chance of survival if it went against the needs of cattle husbandry over any prolonged period of time.

We dispose of a few sources dealing with bull-racing but they cannot provide precise localization and dating for the origin of the sport. One commonly heard explanation, echoed by Payne (1973), is that the sport originated on the island of Sapudi at least 100 years ago as informal races atop harrows. This explanation seems plausible because the same position is adopted by rice field harrowers today in order to make the instrument sink well into the mud. According to legend, bull-racing was a much more ancient creation of the Madurese king Sang Raja Pangeran Katandur in the 12th or 13th centuries who wanted to provide a distraction for his subjects (Noer and Maduratna 1976). While such a royal beau geste was likely to have been little more than political myth, it does seem that Prince Noto-koesoemo inaugurated the first official races offering prizes in silver and clothes in the 1870s. After 1895, similar events were regularly organized and financed by the government in Sumenep with the expressed goal of improving the island’s cattle (Munnik 1929:116-7). By the beginning of this century, official races were being held at the western end of Madura (Léon 1901:463). This indicates a rapid diffusion throughout the island.

Today, kerrabhan sapê is best known as a race, with winners and losers, betting and prizes. There exist, however, three sorts of races, only two of which are entirely competitive. First, there are the championship competitions organized by the Directorate General of Animal Husbandry at each level from the subdistrict qualifying races to the All-Island Finals in Pamekasan in September or October. Second, competitive races may be organized on an ad hoc basis, with help of Animal Husbandry officials, to entertain tourists and dignitaries or to enliven a commemorative occasion. Both kinds of competitive races attract large crowds and growing numbers of tourists. For the owners of competition bulls, their animals are an investment which can be sold at a profit following a win in a big race. The bulls are trained and pampered to the extreme, and their owners would scarcely

dream of making them earn their keep by ploughing or pulling a cart. Third, alongside these competitions, is a different variety of kerrabhan sapê, still existing in some villages, which probably resembles earlier forms of the sport; it may provide a more accurate idea of the role such race animals play in their community. In Batuputh and nearby, for example, the kerrabhan sapê is more a ‘running of the bulls’ than a race, with pairs of all ages and sizes sent one after the other down the length of a rugged fallow field. No betting or prizes are awarded, but the bulls are given new names in a ceremony (lok-lok) allowing their owners or trainers to demonstrate their oratorical flair or dancing talent (Bouvier 1989). In the village, the primary compensation for raising bulls over cows comes in the form of prestige for breeders of prime specimens. In a pragmatic response to the need for bulls and a selection mechanism, prestige is awarded by the community to those who accomplish the costly job of raising animals poorly suited for the average household budget. These peasants keep costs within their own means, however: the animals are used for ploughing if necessary and rarely are they provided the lavish rations of their ‘professional’ counterparts.

This does not mean that other factors have no part to play in bull-racing or similar sports, as can be demonstrated in both explanatory and interpretive approaches. As De Jonge (1990) points out, the Madurese bullfight (aduan sapê) found in East Java serves a variety of purposes by, among other things, providing a mechanism of settling feuds and other conflicts between people, emphasizing community solidarity in opposition to outsiders, offering occasions for festivity and betting, and affording opportunities to assert one’s sexual identity. Many of these observations can be made for Madurese bull-racing as well. The complex forms that sporting practices like bullfighting and racing have given rise to cannot be entirely described in ecological or economic terms; psychological and other considerations also come into play. Yet, these functions of sport can still be integrated into a systems model. Unfortunately, our knowledge of early forms of kerrabhan is largely speculative, and more study of bull husbandry in a variety of habitats is needed. But the festive atmosphere and solidarity surrounding both bullfights and races reinforces the prestige of such sports, the community’s interest in maintaining them, and ultimately, the value of raising bulls. There is no contradiction between these. Other economic and social benefits of bull-races (and probably bullfights) are to be found in the regional integration such sports encourage by bringing dispersed settlements together for collective entertainment, information exchange, and trade. Where people can profit economically, socially, and psychologically from a sport, there is additional pressure to maintain it. What materialist analysis offers is a probable hierarchy for the factors involved in cultural processes, through a dialogue between theory and accumulated ethnographic
knowledge. Faced with choosing which of the above are the primary causal factors, we would be inclined to prefer those which are most closely tied in with the imperatives of material production and reproduction, though still recognizing the importance of other factors for regulating elements of the system.

Recent observers have lamented the poor state of the breeding stock, in part due to selection criteria based on suitability for kerrabhan sapê rather than the needs of an expanding beef industry (Payne 1973; Depnner 1979). They have called for more emphasis to be placed on maximizing the breed's potential for liveweight gain through upgrading. Advocates of selection criteria aimed at raising productivity have yet to come forward with convincing evidence that Madura can provide the additional fodder resources necessary to support larger animals. While there is room for improvement in Madurese animal husbandry, extreme care must be exercised when introducing new breeds, so as not to lose desirable traits. For the time being, bull-races might well insures that selection and raising of bulls is carried out in the villages in such a way as to favour traits that are adapted to the needs of peasants and the constraints of their environment. The cost to the government is small and peasants have access to quality bulls for very low fees, rarely exceeding Rp 1,000 or several eggs.

Of course, communities could have dealt with the problem of bull shortage in other ways. Cooperative systems could have been developed to select and raise bulls collectively. The government could have intervened on a massive scale. In the absence of either, smallholders in isolated villages before the advent of tourists and Presidential Trophies found that the kerrabhan sapê could provide a useful addition to their cattle complex.

Conclusion

Offered a choice between indigenous and high-yielding maize, peasants opt to retain their traditional variety because it fits better into an agricultural system integrating a variety of crops and animal husbandry. Household animal husbandry, in turn, makes agriculture possible in dry field agricultural systems dependent on unpredictable rains. Under such conditions in East Madura, where soil is loose and fodder scarce, the value of female cattle rises above that of males. Kerrabhan sapê might have stimulated the necessary adjustment in value to underwrite the maintenance of adequate and improved breeding stocks.

While the complexity of these cultural traits certainly cautions against any single-factor explanation, efforts to explain particular facets of Madurese culture can be aided by conceptualizing them as parts of systems. Using a system model requires, however, that we identify and weigh causal forces.

Cultural materialism provides a systemic approach that focuses attention on underlying material conditions and constraints on the premise that the most important factors are those governing the way societies and individuals attempt to satisfy basic needs within particular environments (Harris 1983:325). Where, for example, cultural practices are directly or indirectly efficacious for the provision of goods and services or promote subsistence and security at the household and community level, as has been found in the Madurese adherence to local varieties of maize in dry areas or the valuation of bulls through racing, the indications are that material factors do indeed play a significant role, if not in creating, at least in reinforcing these practices.

The need for a more adequate consideration of material processes is most vital where questions of development policy are involved, since decision-makers may be more apt to tamper with a functioning system if 'irrational' cultural factors are thought to be in control. Only by taking into account the specific environmental, social, and institutional context can a complete calculation of the costs and benefits of various options be obtained. Such undertakings could be facilitated by increased local input into research and policy. This and similar studies of Madurese culture suggest that ecological models, combined with a materialist approach, can stimulate productive dialogue between academic and applied anthropological research.

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