Community-Based Fish Culture in Seasonal Floodplains

M.M. Dey and M. Prein

Abstract

During the rainy season in extensive river floodplains and deltaic lowlands, floods render the land unavailable for crop production for several months each year. These waters are considerably underutilized in terms of managed aquatic productivity. This raises the opportunity to enclose parts of these floodwater areas to produce a crop of specifically stocked aquatic organisms aside from the naturally occurring 'wild' species that are traditionally fished and are not affected by the culture activity, resulting in more high-quality, nutrient-dense food production and enhanced farm income for all stakeholders, notably the poor. The WorldFish Center and its national partners recently tested the concurrent rice-fish culture in the shallower flooded areas and the alternating rice-fish culture in the deep-flooded areas of Bangladesh and Viet Nam through a community-based management system. Results indicate that community-based fish culture in rice fields can increase fish production by about 600 kg/ha/year in shallow flooded areas and up to 1.5 t/ha/year in deep-flooded areas, without a reduction in the rice yield or wild fish catch.

Introduction

The past decade has seen growing recognition of the crisis facing the world's water resources and the need for concerted action to use them more efficiently. The efficiency of water use (or water productivity) can be increased by producing more output per unit of water used, or by reducing water losses, or by a combination of both. So far, strategies for increasing output have been limited to crop cultivation only. Water productivity at several organizational levels can be increased further by integrating fish and other living aquatic resources into the existing water use systems. Such opportunities for integration include community-based fish culture in irrigation schemes and seasonal floodplains.

A variety of studies show that the reservoirs and canals of irrigation systems continue to yield substantial fish harvests, which are an important source of protein and livelihoods for the poor and landless households. Yet the current use of irrigation systems and floodplains for fish production falls far short of its potential. In seasonal floodplains, where wild fish enter, reproduce and are harvested from the flooded fields, fish production essentially results from capture activities by seasonal or part-time fisher-farmers. In the Cambodian floodplains, the value of fish caught through trap ponds within rice fields is 37-42 per cent of that of rice production (Gregory and Guttman 1996; Guttman 1999).

A number of studies were conducted in the 1980s to test the technical feasibility of culturing fish in seasonally flooded rice fields in India (Roy et al. 1990; Das et al. 1990; Mukhopadhyay et al. 1991), Bangladesh (Ali et al. 1993, 1998), Cambodia (Gregory and Guttman 1996; Guttman 1999, 2000), and Viet Nam (Rothuis et al. 1998a, Rothuis et al. 1998b). These studies showed that fish production can be increased by more than 1 t/ha/year by stocking flooded rice fields with fish (i.e., individual farmers fencing their plots and stocking fish during the flood season). In addition, the culture of fish within rice fields can increase rice yields, especially on poorer soils and in unfertilized crops where the fertilizing effect of fish is greatest (Halwart 1998). Savings from lower pesticide use, earnings from fish sales and increased yields result in net incomes that are 7 to 65 per cent higher than for rice monoculture (Halwart 1998). But the adoption of this technology by farmers has been very low due to the high cost of fencing individual plots.

The WorldFish Center recently established a new approach in Bangladesh and Viet Nam, where fish is cultured communally during the flood season and the same land is individually cultivated with rice during the dry season. The results of initial trials show a 10 per cent lower cost of rice production and a net return from fish production of US$400/ha in the Ganges and Meghna floodplains (Bangladesh), US$340/ha in the Red river delta (Viet Nam), and US$220/ha in the Mekong delta

(Viet Nam). Significantly, these benefits were obtained with no reduction in the wild fish catch, composed mainly of small indigenous species (SIS). The returns from the sale of the fish produced were distributed among the group members according to a sharing arrangement that they pre-negotiated at the beginning of the season. Gains to the landless were in the form of cash income, which was significant as they did not have any alternative income generating opportunities.

There are many options for enhancing food production from fish in managed aquatic systems. The most appropriate technology will vary from country to country and site to site. Additionally, the social and economic conditions under which these technologies can be implemented need to be understood. Although our studies in Viet Nam and Bangladesh demonstrated the feasibility of the community-based fish culture systems, much more work is needed to understand the social and economic viability of these approaches under different socio-cultural and institutional environments, and to design appropriate institutional arrangements for different social settings. Similarly, the governance arrangements for fish culture in irrigation systems (canals, fields, reservoirs) also require detailed analyses if the full social value of these resources is to be harnessed.

At the ecosystem or basin level, water provides a wide range of goods and services, all of which need to be considered in the broader analyses of the value obtained from water. Most of the previous studies of water productivity have concentrated on measuring the value of crop production only, and excluded the existing and potential contributions by living aquatic resources. There is, therefore, a need not only to increase water productivity, but also to improve the methodologies for measuring water productivity.

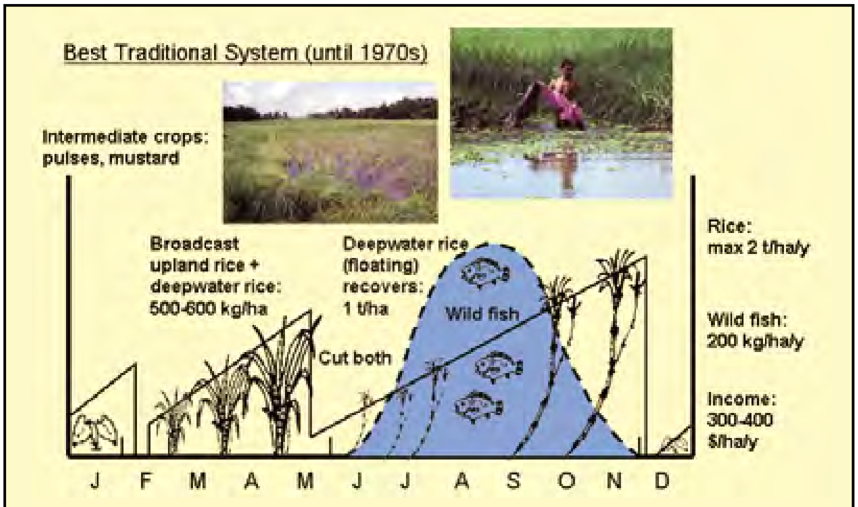

Figure 1. Farming systems evolution in floodprone areas.

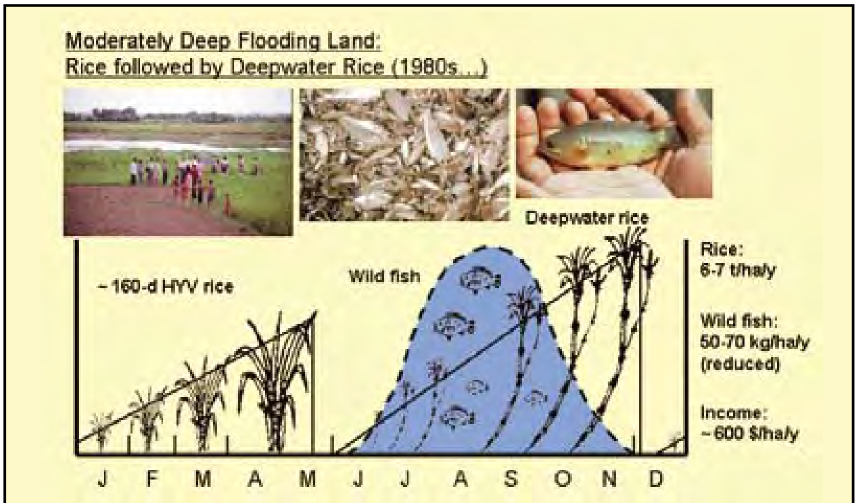

Figure 2. Farming systems evolution in floodprone areas.

Floodplain Farming System Evolution

Farming practices in the flood-prone ecosystem are governed by a number of interacting physical factors, of which the chief ones are the flooding regime (onset, depth, recession, and variability), topography, rainfall pattern, soil texture and the water management regime. Traditionally, farmers used to grow deepwater rice and capture fish during the rainy/flood season and subsequently cultivate a wide range of crops (such as pulses, oil seeds, and vegetables) during the post-flood dry season (Fig. 1). In the Gangetic floodplains (Bangladesh and eastern India), farmers used to get a maximum 2 t of traditional rice and approximately 200 kg of wild fish/ha/year, with an average income of about US$300/ha/year.

Over the last few decades, the flood-prone ecosystems in Asia have undergone some dramatic changes due to the establishment of deep wells (for example, in Bangladesh and eastern India) and construction of the Flood Control Drainage

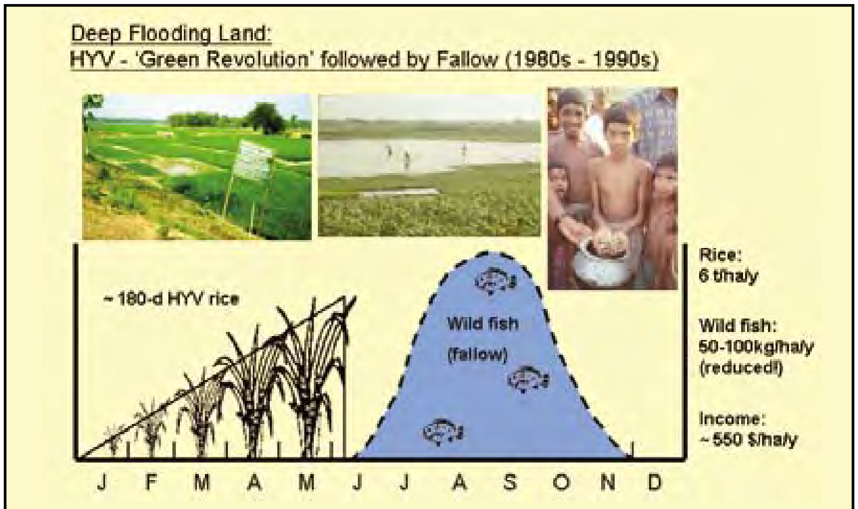

Figure 3. Farming systems evolution in floodprone areas.

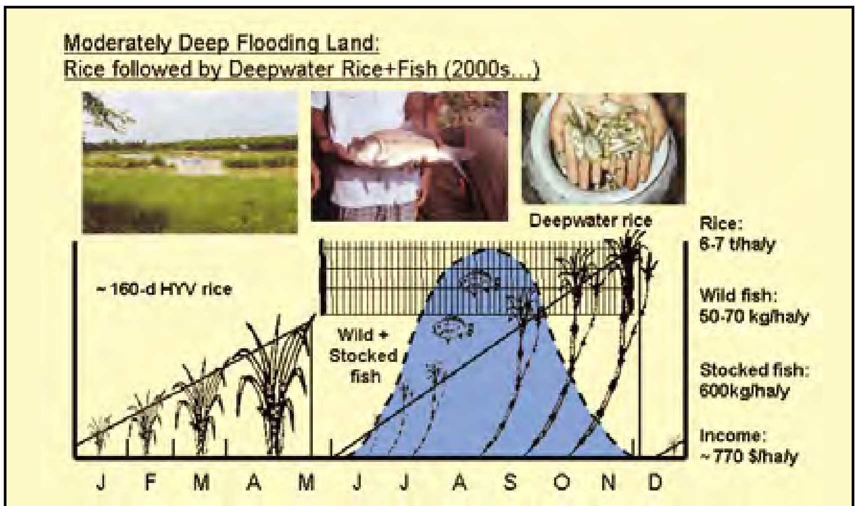

Figure 4. Farming systems evolution in floodprone areas.

and Irrigation (FCDI) systems. With the availability of irrigation facilities, farmers grow high yielding varieties (HYV) of rice in the dry season under irrigated conditions. In the Gangetic floodplains, the dominant farming pattern in shallow flooded areas is irrigated HYV rice during the dry season, followed by transplanted deepwater rice varieties during the rainy seasons (Fig. 2); while the dominant pattern in deep flooded areas is single-crop irrigated HYV rice (Fig. 3).

Late harvest of HYV dry season (winter) rice does not allow timely establishment of a deepwater rice crop in the deep-flooded areas during the rainy season.

In shallow flooded areas in the Red river delta (in northern Viet Nam), farmers generally grow high yielding irrigated rice during the dry season, and a tall-growing local or higher yielding variety during the rainy season. In the Mekong delta of southern Viet Nam, where rice fields are also deeply flooded in the rainy season, two irrigated crops of high yielding rice varieties are grown with a flood fallow period in between. Although the introduction of irrigation-based 'green revolution' technology has increased the total rice production in flood-prone areas (from about 2 t/ha/year to about 6-7 t/ha/year), the wild fish harvest from flooded rice fields has declined substantially (from 200 kg/ha/year to less than 100 kg/ha/year).

An opportunity for further increasing production in the flood-prone ecosystem is in the integration of fish culture with rice farming. The flood-prone areas are seasonally flooded during the monsoon and remain submerged from four to six months. In these flood-prone areas, land ownership is fixed according to tenure arrangements during the dry season. But during wet season floods, individual land holdings are not visible and waters are a community property granting all members access to fish in all areas of the community. Therefore, it is essential that the rice-fish culture activity in the flood-prone ecosystem is undertaken by the rural community using a group approach. The group should include the landless as they have traditionally accessed the flooded areas for fishing, but would lose this essential resource if they were denied access because the areas were stocked with fish.

Generally, three types of rice-fish culture systems can be established in flood-prone areas: (i) concurrent culture of deepwater rice (with submergence tolerance[1]) with stocked fish during the flood season followed by dry season

[1] Rice variety used in areas of shallow to moderate flooding depths, in which young plants tolerate total submergence of leaves for up to 10 (some varieties maximum 20) days and after this period grow quickly and produce panicles.

rice in shallow flooded areas; (ii) concurrent culture of deepwater rice (with elongation ability[2]) with stocked fish during the flood season, followed by dry season non-rice crops; and (iii) alternating culture of dry season rice followed by stocked fish only during the flood season (i.e., without rice) in an enclosed area (e.g., as in a fish pen).

The WorldFish Center and its national partners recently tested the concurrent rice-fish culture given as option (i) above (Fig. 4) in shallower flooded areas, and the alternating rice and fish culture option (iii) (Fig. 5) in deep-flooded areas of Bangladesh and Viet Nam through a community-based management system. Results indicate that community-based fish culture in rice fields can increase fish production by about 600 kg/ha/year in shallow flooded areas and up to 1.5 t/ha/year in deep-flooded areas, without a reduction in the rice yield or in the wild fish catch. These (Fig. 6) and other potential technical options need to be tested and validated in various floodplains of Asia and Africa under varying institutional arrangements suitable for locally prevailing socio-cultural-economic and political conditions.

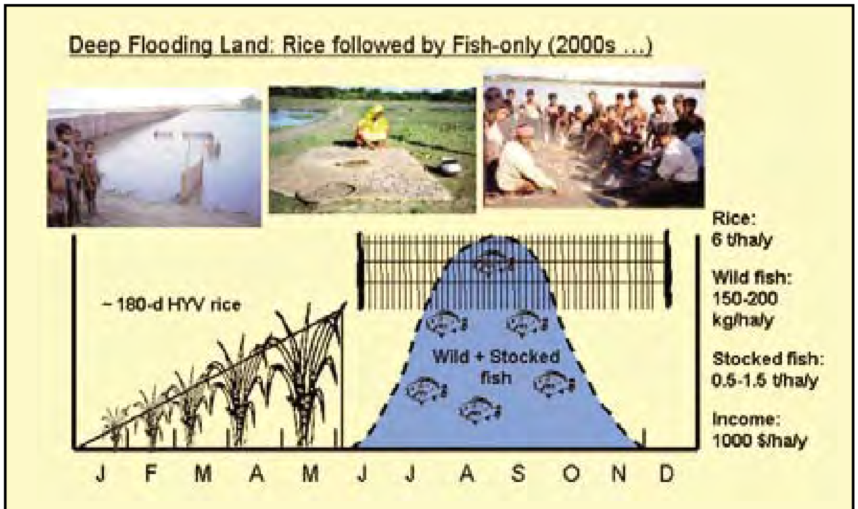

Figure 5. Farming Systems Evolution in Floodprone Areas.

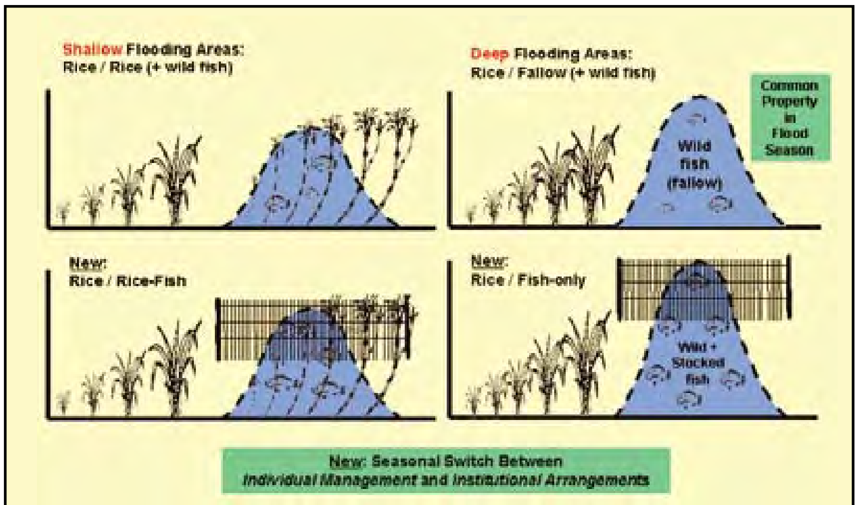

Figure 6. Farming Systems Evolution in Floodprone Areas.

Conclusions From Recently Conducted Trials

In the trials conducted over a three-year period in Bangladesh and northern and southern Viet Nam, the approach taken was that communities were encouraged to determine the management criteria and institutional arrangements which they considered suitable to their local conditions and social environment. Further details are provided in Dey and Prein (in press).

Institutional arrangements

Arrangements between stakeholders are necessary. During the flooded season when individual plots are not discernable, the water body becomes a temporary common property in contrast to the dry season when individual land holdings are clearly discernable and respected. This approach is needed to exploit the resource.

A group approach was used, with around 20 households per group, comprising landowners, fishers of the community and landless laborers (holding customary access rights for fishing in the flood season). Benefit arrangements were required to organize and consolidate the group. Landowners comprised of participating (active) and non-participating (passive) persons. Landowners participating actively in the group activities received an additional share of the benefits for their role as group members (on top of the share they already

[2] Rice variety used in deepwater areas with longer flooding durations of up to 4-5 months in which the stems have the ability to elongate quickly in response to increasing flooding depth.

received through mere provision of their land).

It was found that existing social harmony among the groups before the introduction of the community-based fish culture approach was a requirement for its successful implementation. Artificial memberships based on previous linkages with facilitating organizations (e.g., NGOs) proved to have destabilizing effects or were even detrimental. The predisposition of the population to community-based activities in some countries also was an important determinant. For example, in southern Viet Nam farmers were highly averse to any form of group arrangements, even if these involved close relatives, and preferred individual management of smaller, individually owned and controlled areas. Further assessments of the attributes of successful group approaches and the reasons for spontaneous adoption and spread of the technology are planned in the near future.

Selection of concurrent versus alternating systems. The selection is dependent upon the flooding pattern in the area and the preferences among the groups.

Selection of appropriate sites. The sites should be in topographically suitable areas and existing embankments should be included as much as possible. Initially the number of suitable sites was perceived to be limited. However, spontaneous adopters fenced up to 75 per cent of the perimeter of the enclosed areas (the remainder being existing embankments) at a comparatively high cost. Nevertheless, these sites still proved to be highly profitable.

Fish species, stocking densities, sizes. Recommendations were given on stocking densities of several fish species in a polyculture system, preferably of larger sizes to avoid predation and to achieve greater sizes at harvest. However, these were not prescriptive packages (to avoid straightforward rejection) and the numbers of individual fingerlings and species proportions actually stocked depended on the local availability from hatcheries and other sources. Given the size of some of the enclosed areas, these were large numbers, far greater than the usual requirements for fish ponds. This, together with the preference for larger sizes and several different species, posed considerable logistical challenges (sourcing, transport) to the communities and the facilitating NGOs.

Market supply versus timing of harvests. Both the capture phase for wild fish and the harvest phase are bound to coincide as they depend on the flood duration, levels and recession pattern. However, the culture operation can be staged over a longer period through sequential harvests leading to thinning out of the standing fish stock for higher growth and greater returns. Further, deeper pits in the area can be used to keep fish beyond the normal capture season until fish prices increase and greater returns from markets can be achieved. This was done by some of the trial groups.

Financial management issues. In the first year, the communities received financial support for the initial investment in fences. In subsequent years, communities were expected to reinvest a portion of their proceeds from the previous year's fish sales into the subsequent year's fish culture operation, e.g., for the purchase of fish fingerlings and the maintenance of the fences.

Effects on biodiversity (wild fish). Although no specific analyses were conducted as part of these early trials, it was generally observed that wild fish biodiversity and abundance were not affected by the culture operations. The conclusion is based on comparisons of the wild fish catch (biomass and species composition), which was essentially similar, except for reduced catches of predators such as catfish (Clarias sp.) and snake head (Channa sp.).

However, in some cases farmers observed that the biomass of small indigenous species was considerably higher than in neighboring unfenced areas and a few species that had previously been rare in their areas, had appeared again in their catches in the fenced areas. This was attributed to the reduced abundance of predators within the fenced areas.

More detailed studies are required to validate the presumptions that stocking fish into fenced areas of seasonally flooded waters has no negative effects and that the fences control the access of juvenile predatory fish into the fenced areas as the flood waters rise.

Beneficiaries and Impact

Globally, freshwater fisheries are the most heavily exploited aquatic resource, producing about a quarter of the world's food fish from less than 0.01 per cent of the world's water resources. However, over exploitation is only one of many threats to inland aquatic resources: water resources development for agriculture and other habitat modifications, invasive species and pollution are serious threats and make freshwater biota the most threatened components of global biodiversity. Yet, these fish are of the highest importance for the rural poor for income, quality nutrition and food security. Fish have a high nutritive value due to their proteins, oils and micro-nutrients which are in a highly bio-available form in most small fish species. Fish demand is increasing, as reflected in constant price rises.

Fish production from the fenced floodplain areas can be increased two to tenfold over the natural catch through culture activities, as shown from our work in Bangladesh and Viet Nam. Harvests are in bulk and are, therefore, sold on the market producing cash returns that are shared among group members, including the landless. Capture of non-stocked, small indigenous species by the landless using traditional fishing methods within the culture areas during the culture period is specifically permitted by the groups and thereby ensures a continued supply of protein and income over the culture season from the fenced areas. Cash income is increased for all involved, notably for the landless, relative to their base income. We expect similar levels of benefits from group-based fish culture approaches in irrigated systems.

In the longer term, the approach aims to provide rural populations in the floodplain areas and irrigated systems of the targeted basins with an equitable source of additional income and supply of fish, both from natural fish production as well as from stocked culture species. This will directly benefit the members of the communities involved as well as fish consumers outside the culture areas due to the increased supply on the markets, thereby countering the negative trend in production from inland fisheries. Revenues from fish production can also be used to improve the maintenance and, hence, the sustainability of irrigated systems.

Extrapolation Domains

The potential application areas for the community-based fish culture approach in floodplains and irrigation systems are considerable. These areas are usually densely populated. However, the seasonal floodwaters are underutilized.

This approach helps to mitigate the trend of declining production from inland capture fisheries accompanied by increasing price of fish, making it less affordable to the poor. For example, in Bangladesh there are 3 million ha of medium and deep flooded areas, out of which about 1.5 million ha are estimated to be suitable for community-based fish culture. If this approach is adopted in only 50 per cent of these areas, annual fish production will increase by 450 000 t (additional to the presently produced 60 000 tonnes of wild fish caught in these areas) with an approximate value of US$340 million, and will be of benefit to an estimated 6.7 million people (2.7 million of which are landless and/or functionally landless). Similar opportunities are seen for floodplain and deltaic systems in other countries in Asia and Africa.

In the Mekong river basin, there are 0.8 million ha of medium and deep flooded areas that could be utilized by the local communities for joint fish culture activities during the flood season, which is otherwise a fallow season with very low economic and agricultural activity. Of the 5.2 million ha of medium and deep flooded areas in the Indo-Gangetic basin, 3 million ha are in Bangladesh, wherein an estimated 27 million potential direct beneficiaries live. If only 25 per cent of these adopt the approach, 6.7 million would benefit, of which 2.7 million persons are landless. Other areas suitable for this approach in other river basins in Asia are in Myanmar (1.2 million ha), Thailand (0.7 million ha), and the Red river delta in Viet Nam (0.1 million ha).

In Africa, the potential for application of community-based fish culture is greatest in seasonal floodplains and in irrigation schemes. In the West African floodplains, 470 000 ha are used to grow deepwater rice (Catling 1992) which could be used for concurrent deepwater rice and fish culture.

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