TROPHIC FUNCTIONING OF INTEGRATED RICE-FISH FARMING IN MADAGASCAR: INSIGHTS FROM STABLE ISOTOPES ($\delta^{13}C$ & $\delta^{15}N$)

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Integrated rice and fish farming (IRF) with aquatic animal aquaculture (i.e. rice-fish farming) is an ingenious agricultural system that produces fish and rice within the same plot using the same amount of water, while benefitting from synergistic effects. Indeed, fish such as common carp (*Cyprinus carpio*, L.) influence nutrient dynamics through consumption, excretion and bioturbation, which ultimately benefit the rice. However, the potential of IRF to address challenges related to food security and to alleviate poverty is constrained by the small fish yields obtained in traditional Malagasy systems (from 50 kg ha^{-1} $cycle^{-1}$ to 350 kg ha^{-1} $year^{-1}$, on average). Fish yields could be improved by increasing natural productivity through organic fertilization. However, high biodiversity in rice field suggests complex trophic interactions which may affect ecosystem functioning as well as ecological intensification of aquatic food production. Trophic dynamics of IRF systems were thus studied in extensive irrigated rice plots stocked with common carp in Madagascar. Fish feeding behavior was assessed by analyzing stable carbon and nitrogen isotopes of fish and natural food sources.

Stable isotope signatures of 45dayold carp fry introduced into rice plots ($\delta^{13}C$ = 18.8‰ ± 0.5‰, $\delta^{15}N$ = 9.3‰ ± 0.6‰) revealed that they had been fed chicken egg yolk and corn meal, in accordance with local practices. However, after a 100day growing period in experimental rice plots, ^{13}C and ^{15}N depletion was observed for 145dayold carp, indicating a change in feeding sources. Under extensive conditions, common carp that fed on rice roots, sediments and suspended particulate organic matter (i.e. plant debris and detritus) had a larger trophic niche (3‰^{2}) than 45dayold carp (1.2‰^{2}).

Overall, common carp feeding behavior and the trophic food web in the IRF system confirms that increasing natural productivity through organic fertilization (e.g. rich in nitrogen, carbon and phosphorus), instead of synthetic fertilizers and feeds, should help increase natural productivity and enhance ecological intensification of both rice and fish production. However, further research is needed on the contribution of insects, weeds and zooplankton to the common carp diet, as well as studies integrating native species from multiple trophic levels.

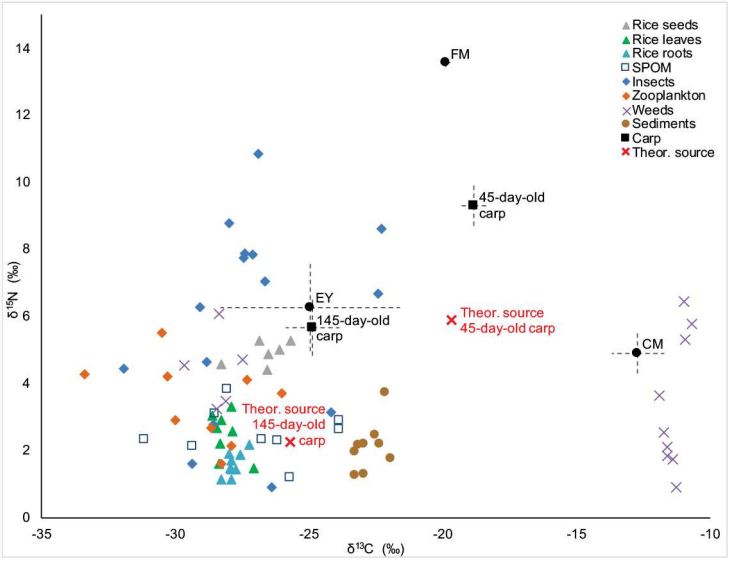

Fig. 1: Mean isotopic signature ($\delta^{13}C$ & $\delta^{15}N$) of common carp, theoretical food source and trophic compartments collected from extensive rice plots