Supplementary Material
Whose gap counts? The role of yield gap analysis within a development-oriented agronomy

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1 Methodological details

1.1 Labour productivity

Field-specific data about the quantity of labour used for rice cultivation, as well as the source of that labour, was analysed to study labour dynamics in Central Luzon between the period 1979 - 2012. Understanding changes of labour use and source in agriculture is key to explain crop management as it directly relates to opportunities available off-farm. Labour use is quantified in labour-days (ld) ha^{-1}.

The main sources of labour are family members (family labour), neighbours and relatives (exchange labour), hired landless peasants (hired labour) and permanent labourers (permanent labour). Family labour refers to household members directly involved in rice farming and it is mostly used for activities which require care and precision (e.g. fertiliser application). Exchange labour is a peculiar labour arrangement in which members of one household help members of another household in exchange for a similar amount of labour of the latter household in the fields of the former household. This type of labour was categorized as family labour. Hired labour has been very popular in Central Luzon and can take two forms: 1) hiring of temporary workers to perform labour demanding activities such as transplanting and harvesting or 2) hiring of permanent labourers who are responsible for all the crop management activities in exchange for about 10% of the final paddy production. Most of the hired labour is performed by landless peasants. The share of family and hired labour to total labour use, and its temporal trend, for rice cultivation was quantified in absolute terms independently of the crop management activities.

The mean labour use per crop management activity, and its temporal trend, were also analysed. Five different crop management activities were identified namely land

preparation, crop establishment, fertiliser application, pesticide application and, harvesting and threshing. Land preparation refers to all operations performed in the field prior to the establishment of rice such as ploughing, harrowing and levelling and it is normally done either using animal traction or mechanical hand tractor. Crop establishment consists of the broadcasting of pre-germinated rice seeds in case of direct-seeding or of seedbed preparation, pulling, bundling, hauling and transplanting of the seedlings in case of transplanting. Finally, harvesting of rice panicles is mostly done manually while threshing is done in the field with the help of a small portable thresher.

1.2 Farm profitability

Rice profit was calculated as the difference between revenues from selling rice and the costs of material inputs and hired labour used by each household. Rice revenues were estimated as the quantity of rice kept by the household (this corresponds to a 'best case' situation as the quantity of rice sold by each household is far lower than the quantities of rice kept for home consumption) and the market price for rice. Production costs associated with rice cultivation were estimated from the amount of material inputs and hired labour used and the unitary prices paid for them.

1.3 Rice self-sufficiency

The land required to achieve rice self-sufficiency was quantified based on annual rice supply and annual rice demand of each unique household $\times$ year combination available in the Central Luzon loop survey (Hengsdijk *et al.*, 2014).

Annual rice supply was calculated based on the quantity of rice kept by each household on a yearly basis, i.e. in both WS and DS. This was calculated as the difference between total rice production and quantity of rice used to pay permanent workers and harvest activities. Total rice production was computed from the cultivated area and rice actual yields adjusted to 14% moisture content (expressed in kcal). Areas and yields reported for each growing season were summed and expressed on a yearly basis. Roughly 75% of the total rice produced on-farm was kept by the household across the period of the analysis, while the other 25% was used for in-kind payments of harvesting activities (e.g. harvester and threshing), leasing of land or permanent labourers. Finally, the quantity of rice kept by the household was corrected to a constant milling rate of 65% and post harvest losses of 37% (IRRI Rice Knowledge Bank).

Annual rice demand was estimated based on the number of household members and their energy requirements per year. There was a slight decline in the number of household members during the study period from an average of ten individuals in 1979 - 1980 to seven individuals in 2011 - 2012. There were also drastic changes in annual per capita rice consumption in the Philippines from about 105 kg capita^{-1} year^{-1} in 1980s and 1990s up to 129.4 kg capita^{-1} year^{-1} in 2000s (USDA and FAOSTAT databases)[1].

[1]It is important to mention that our results may under-estimate the rice area required for rice self-sufficiency as *per capita* rice consumption may be considerably higher in Central Luzon. As an example, the average *per capita* rice consumption recorded in a recent household survey conducted by IRRI in

These were converted to energy units by assuming an energy content for rice of 3630 kcal kg^{-1} (Quilty *et al.*, 2014). Energy requirements of household members under 18 years old were assumed to be on average 50% of those of an adult.

A 'land deficit' was identified for the households unable to produce enough rice to meet the energy needs of the household members, i.e. for households in which the demand for rice was greater than the supply from their fields. The land deficit thus indicates how much additional land would be required for a household to achieve rice self-sufficiency given observed actual yields. In contrast, a 'land surplus' was identified for the households which were able to produce rice beyond household energy needs; hence it indicates the area which is not required for rice self-sufficiency.

References

Hengsdijk, H., Franke, A.C., van Wijk, M.T. & Giller, K.E. (2014). How small is beautiful? Food self-sufficiency and land gap analysis of smallholders in humid and semi-arid sub-Saharan Africa. Tech. rep., Plant Research International, Wageningen UR.

Quilty, J.R., McKinley, J., Pede, V.O., Buresh, R.J., Correa, T.Q. & Sandro, J.M. (2014). Energy efficiency of rice production in farmers' fields and intensively cropped research fields in the Philippines. *Field Crops Research*, 168, 8 – 18.

2014 was about 170 kg $capita^{-1}$ $year^{-1}$ (data not shown).

2 Supplementary figures

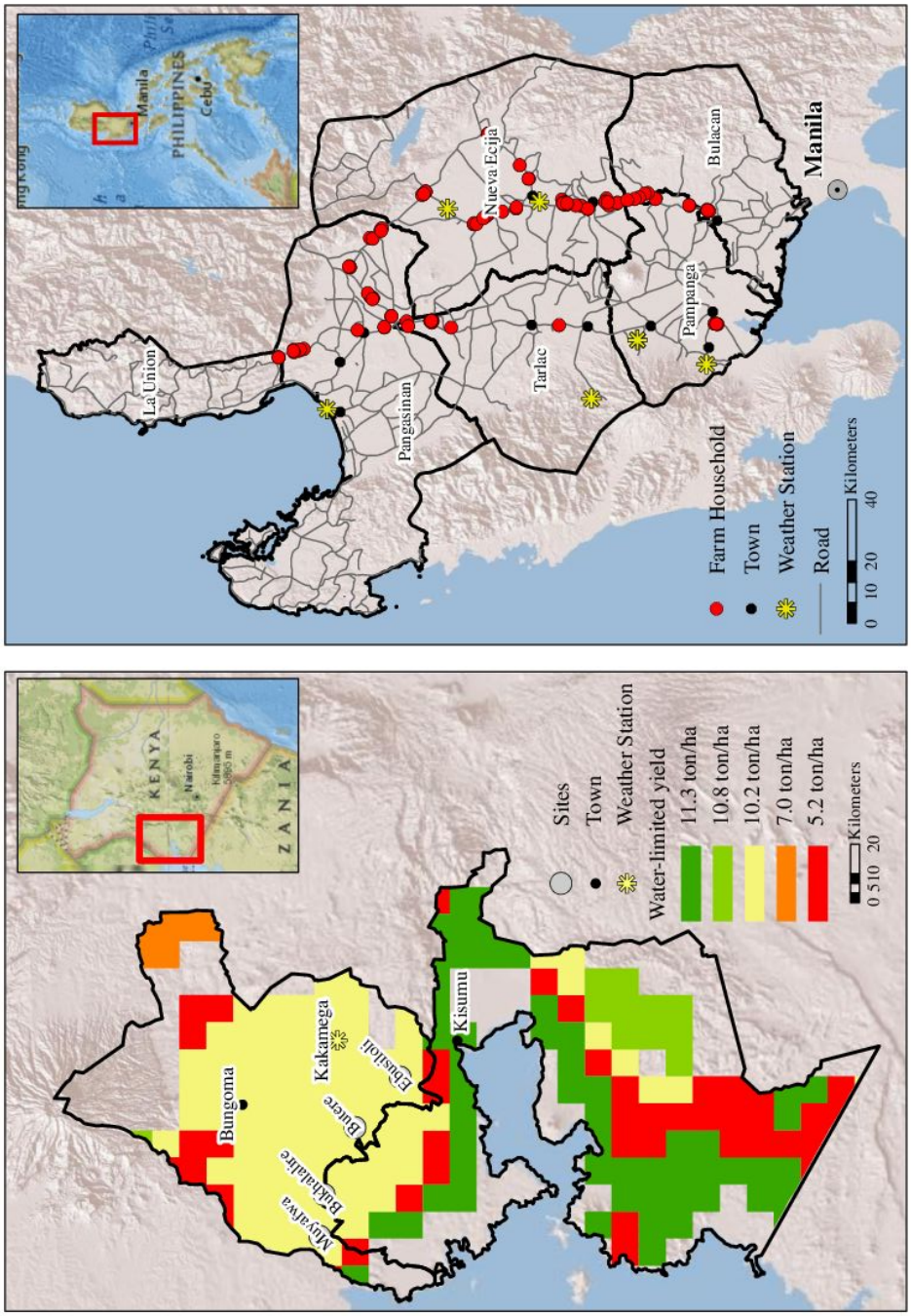

Figure 1. Location of the study sites in Kenya (left) and the Philippines (right). Water-limited yields in Kenya were retrieved from GYGA and correspond to the average over the period 1998 - 2014. Households in the Philippines were interviewed within the Central Luzon Loop Survey.

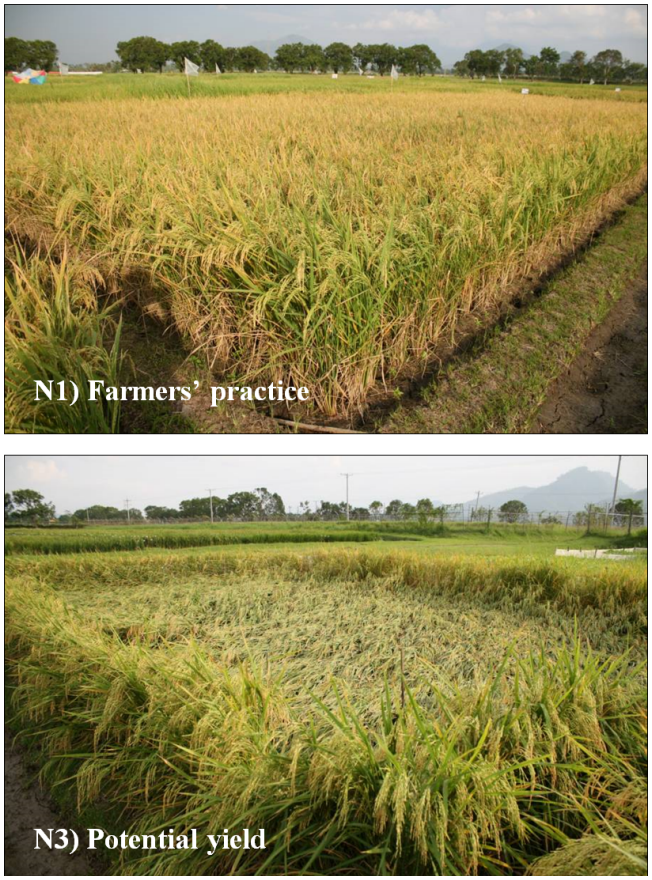

Figure 2. Lodging of rice in a field trial in IRRI experimental station during 2014 WS. The photo on top refers to a treatment replicating the farmers' practices in the region (N application of 60 kg N ha^{-1}) while the photo on the bottom refers to a treatment aiming for climatic potential yield (N application of 180 kg N ha^{-1}). Both photos were taken in the same day a few days after the region was hit by a typhoon. *Source*: João Vasco Silva, IRRI, 23rd September 2014