Integration of GIS into the study of oligopsony in agricultural commodity market
農産物市場における買手寡占の分析における GIS の援用

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Introduction: Lack of buyer competition has been identified as one of the important factors contributing to the poverty of farmers located in remote areas, particularly those within developing countries. While the socioeconomic mechanism behind the occurrence of this problem, commonly known as oligopnony, is well-studied in non-spatial and one-dimensional contexts, extensions of these models into the more realistic two-dimensional setting have not been widespread in the literature, likely due to the absence of an appropriate computational framework to link sellers and buyers geographically. Using the Sri Lankan tea market as a sample case, this study proposes the utilisation of geographic information system (GIS) as a platform for the oligopsony research, with a special attention paid to the spatial relationship between tea farms and tea processing factories.

Materials and methods: The study covers a 760 km^2 (approx. 30km × 30km) area of Rakwana Division, a low-elevation tea-growing region located within the southern part of Sri Lanka. Geographic coordinates of 16 tea processing factories were recorded during the field study, which also involved extensive interviews of tea-producing farmers, factory managers, and tea traders about their respective operations. The average farmgate price offered by each of these factories during the period of July 2012–December 2012 was obtained from Sri Lanka Tea Board and added to the dataset. This layer was next overlain with a binary land use raster, in which 8,824 cells (100m × 100m each) classified as tea fields in the original land use map was filtered (**Fig. 1**). Based on these two layers, the distance between a tea-producing cell and a tea factory was computed for all possible combinations (8,824 × 16) using two definitions: the Euclidean distance and the cost distance. Of the two, the latter considered the road network and, for travel through unsealed paths, the slope of the route. Finally, the size of the market for each factory, hereby quantified by the number of tea-producing cells within a certain distance threshold (5,000m for the Euclidean distance, 10,000m for the cost distance), was calculated, and its relationship with the factory's offer price was examined.

Results and discussion: The average offer price across all observations was Rs 57.46 kg^{-1}, while the average market size was 1,754 cells (ha) and 2,051 cells (ha) based on the Euclidean distance and the cost distance, respectively (**Table 1**). The offer price and the market size showed a high level of positive correlation with the correlation coefficients ρ = 0.65 (Euclidean) and ρ = 0.51 (cost), while the offer price and the average distance to tea farms showed a moderate level of negative correlation (ρ = –0.54 and ρ = –0.38). The findings were robust to changes in the distance thresholds to define the market size. These results suggest that factories on favourable locations are sharing part of their profits with farmers through high offer prices, rather than enjoying the full cost savings owing to their locations. Thus, for the present study area, market exploitation attributable to buyers' spatial placements has not been detected.

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Table 1 Relationship between offer price and market size

Factory #	Price (Rs/kg)	Mean distance (Euclidean: m)	Mean distance (cost: m)	Market size (Euclidean: ha)	Market size (cost: ha)
1	51.9	13,952	24,313	1,037	882
2	57.1	9,515	15,546	2,120	3,145
3	57.6	10,526	18,470	1,517	1,546
4	60.4	9,558	19,367	1,998	1,905
5	55.7	11,594	20,397	1,510	1,618
6	59.7	9,601	18,492	1,441	1,408
7	59.7	9,857	18,010	2,121	2,439
8	49.4	9,635	17,438	1,556	1,547
9	55.2	9,622	16,881	1,664	1,812
10	61.3	9,320	18,737	2,350	2,257
11	59.1	9,180	15,737	2,016	2,910
12	59.0	9,225	16,288	1,926	2,725
13	61.8	9,654	17,018	1,846	2,396
14	54.9	12,029	20,873	1,330	1,574
15	57.9	9,962	17,721	1,542	1,614
16	58.4	9,074	15,308	2,090	3,041
Mean	57.5	10,144	18,162	1,754	2,051
ρ with price	n.a.	–0.54	–0.38	0.65	0.51
P-value	n.a.	0.03	0.15	0.01	0.04

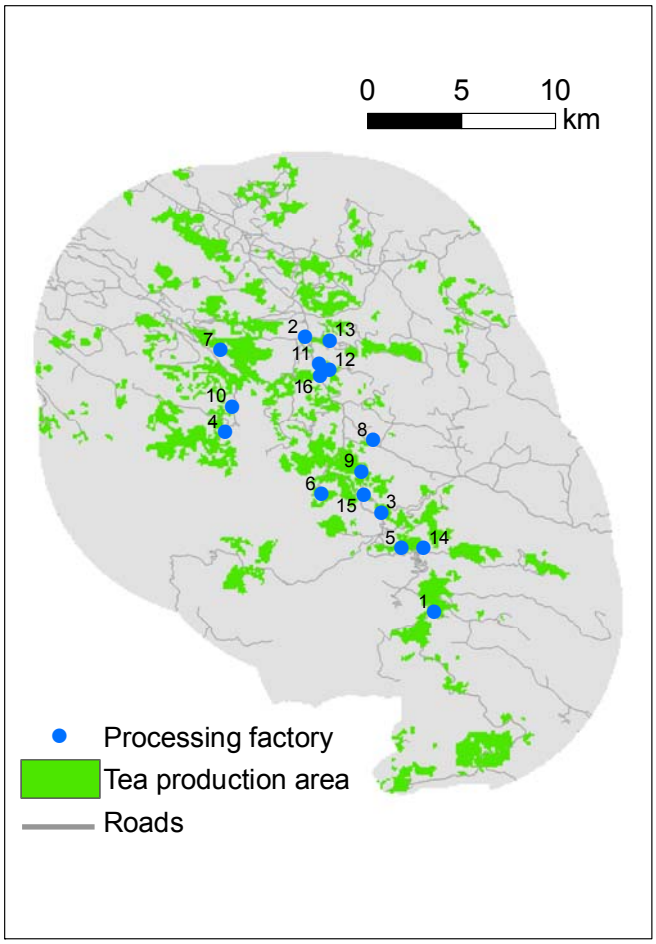

Fig. 1 Map of the study area