Data Article

Data on farmers’ determinants of manure and inorganic fertiliser use in the semi-arid Ethiopian Rift Valley

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**A R T I C L E   I N F O**

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**A B S T R A C T**

This article contains the data on farmers’ determinants of binary choices for manure use (i.e., manure is used or unused) and fertiliser use (i.e., fertiliser is used or unused) at their fields in semi-arid northern Ethiopian Rift Valley. The data includes (i) a schematic diagram that represents local farmers’ distinctions of the crop field types in terms of the distance from their houses and soil fertility and (ii) a table that describes a representative farmer’s crop sequences and soil fertilisation methods in two consecutive years. Details about the literature review of the previous case studies on farmers’ determinants of manure application technique adoption conducted in some parts of sub-Saharan Africa where cattle dung is used for manure are also summarized in a table. A table shows descriptive statistics of the independent variables used in the empirical analyses. Summary statistics of 4 binomial logit models and 4 multinomial logit models are indicated in a table, which represent model fit. Last two tables exhibited in this article show the logit analyses.

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**Specifications Table**

| Subject area | Agricultural Economics |
|--------------|------------------------|
| More specific subject area | Innovative technology adoption study |

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Value of the data

- The data include the figure that describes local farmers’ distinctions of the crop field types in terms of the distance from their houses and soil fertility in semi-arid northern Ethiopian Rift Valley.
- The data include the table that shows a representative farmer’s crop sequences and soil fertilisation methods.
- These data are a benchmark for farmers’ determinants of manure application and fertiliser use at their crop fields in Ethiopian lowlands including semi-arid Ethiopian Rift Valley.
- These data can be compared to the similar type of analyses conducted in other areas.

1. Data

This article includes a schematic diagram representing local farmers’ distinctions of the crop fields in terms of the distance from their houses and soil fertility (Fig. 1), table that summarizes the literature review of the previous case studies on determinants of manure application techniques conducted in other parts of sub-Saharan Africa where cattle dung is used for manure (Table 1), table describing a representative farmer’s crop sequences and soil fertilisation methods in 2011 and 2012 (Table 2). Table 3 shows descriptive statistics of the independent variables used in the empirical analyses. The logit analysis data include the summary statistics of four binomial logit models and four multinomial logit models, which represent model fit (Table 4), variable coefficients of the two binomial logit models, which are selected as appropriate models in Table 4 (Table 5), and average marginal effects of the three multinomial logit models, which are selected as appropriate models in Table 4 (Table 6).

Fig. 1. Positional relationships between homesteads, aradas, masas, and gorbas (drawing by Shiro Mukai).
Table 1
Case studies on determinants of manure application techniques conducted in some parts of SSA.

| No. and sources | Fertilisation | Crops | Dependent variables used | Fertilisation | Crops | Dependent variables used |
|-----------------|---------------|-------|--------------------------|---------------|-------|--------------------------|
|                 |               |       | zones                    |               |       | gender                   |
|                 |               |       | off-farm                 |               |       | training                 |
|                 |               |       | farm                     |               |       | livestock                |
|                 |               |       | labour                   |               |       | market                   |

| No. and sources | Fertilisation | Crops | Target | Food crops | Cash crops | Data | Type | Model | Dependent variables used |
|-----------------|---------------|-------|--------|------------|------------|------|------|-------|--------------------------|
| 1 [6]           | M             | AC    | Mi, So | Pe, Cow    |            | HH   | Bi   | B. L  | "(+)", ns(+)            |
| 2 [7]           | M             | AC    | Ma, Be |            |            | HH   | Bi   | B. L  | "(+)", ns(+)            |
| 3 [8]           | M             | AC    | Ma, So | Cow, Gr    |            | HH   | Bi   | B. L  | "(+)", ns(+)            |
| 4 [9]           | M             | AC    | Ba, Wh | Wh, Be     |            | Plot | Bi   | M. L. | "(+)", ns(+)            |
| 5 [10]          | M             | AC    | Ca, Ma | Ho, Ve     |            | HH   | Bi   | B. L  | "(+)", ns(+)            |
| 6 [11]          | M             | Ma    | Ma, Be |            |            | HH   | Bi   | M. L. | "(+)", ns(+)            |
| 7 [12]          | M             | Ma    | Ma, Wh | Ma, Tef    |            | HH   | Bi   | M. L. | "(+)", ns(+)            |
| 8 [13]          | M             | AC    | Wh, Ma | Wh, Ba     |            | HH   | Bi   | B. P. | "(+)", ns(+)            |
| 9 [14]          | M + F         | Ma    | Ma, Be | Tea, Cof   |            | HH   | Bi   | B. L  | "(+)", ns(+)            |
| 10 [15]         | M + F         | Ma    | Ma, Wh | Ma, Tef    |            | HH   | Bi   | B. L  | "(+)", ns(+)            |
| 11 [16]         | M + F         | Ma    | Ma, Be | Tea, Cof   |            | HH   | Bi   | M. L. | "(+)", ns(+)            |
| 12 [17]         | M + F         | AC    | Mi, So | Gr, Cot    |            | HH   | Bi   | B. P. | "(+)", ns(+)            |
| 13 [18]         | M + F         | AC    |       |            |            | Plot | Bi   | M. L. | "(+)", ns(+)            |
| 14 [19]         | M + F         | AC    | Ma    | Tea, Cof   |            | Plot | Bi   | MV. P.| "(+)", ns(+)            |
| 15 [20]         | M + F         | AC    | Ma    | Tea, Cof   |            | HH   | In   | Tob.  | "(+)", ns(+)            |
| 16 [21]         | M + F         | AC    | Ma    | So        | Cow, Gr    | HH   | Bi   | M. L. | "(+)", ns(+)            |
| 17 [22]         | M + F         | AC    | Ma    | So        | Chat, Cof  | Plot | Bi   | TS. P.| "(+)", ns(+)            |
| 18 [23]         | M + F         | AC    | Ma    | Wh        | Ma, Tef    | HH   | Bi   | M. L. | "(+)", ns(+)            |

Notes:

a M, manure; M + F, manure and fertiliser.
b Crops targeted in each study. AC, all crops; Ma, maize.
c Main food crops grown in each study area. Cow, cowpea; Cof, coffee; Cot, cotton; Gr, groundnuts; Py, pyrethrum; Sug, sugarcane; Ve, vegetables.
d Main cash crops grown in each study area. Ba, barley; Be, beans; Ca, cassava; Chat, Catha edulis; Mi, millet; Po, potato; So, sorghum; Wh, wheat.
e Type of the data collected as dependent variables. HH, household data; Plot, plot data.
f Type of dependent variables. Bi, binary choices of adoption or not adoption; In, intensity of use.
g Econometric model used. B. L., binomial logit; B. P., binomial probit; M. L., multinomial logit; 2SLS, two-stage least squares; MV. P., multivariate probit; Tob., Tobit; TS. P., two-stage probit.

-_, not used; ns, not significant; *P < 0.1; **P < 0.05; ***P < 0.01; Signs (+,−) in parentheses are the signs of the variable coefficients.

851 household and plot data were collected from 123 areas across Uganda [18]. Thus main food and cash crops in each of the study areas were not described here.
Table 2
Crop sequences and soil fertilisation practices of Mr. TY over two years, 2011 and 2012.

| Field no. | Type of the field | Area of the plot (ha) | Distance from farmers’ house (m) | Cropping (fertilisation option and application level) |
|-----------|-------------------|-----------------------|---------------------------------|-----------------------------------------------------|
| 1         | Arada$^a$         | 0.06                  | 0                               | Maize (household waste input)                        |
| 2         | Arada             | 0.5                   | 50                              | Maize (household waste input)                        |
| 3         | Masa              | 0.5                   | 50                              | Tef (compost 0.125 Mg)$^b$ Sorghum (no fertilisation) |
| 4         | Masa              | 0.25                  | 100                             | Haricot bean (compost 0.2 Mg)$^c$ Tef (compost 0.2 Mg + fertiliser) |
| 5         | Masa              | 0.5                   | 200                             | Tef (compost 0.1 Mg + fertiliser) Wheat (fertiliser) |
| 6         | Masa              | 0.25                  | 200                             | Tef (compost 0.1 Mg + fertiliser) Barley (compost 0.1 Mg) |
| 7         | Masa              | 1.0                   | 400                             | Wheat (compost 0.1 Mg + fertiliser) Tef (compost 0.3 Mg + fertiliser) |
| 8         | Masa              | 0.25                  | 700                             | Barley (fertiliser) Tef (fertiliser) |
| 9         | Masa              | 0.25                  | 1000                            | Tef (fertiliser) Haricot bean (no fertilisation) |

$^a$ A backyard field.
$^b$ Mr. TY did not input fertiliser in 2011 but used it when he cultivated tef in 2010.
$^c$ Mr. TY applied approximately 0.16 Mg compost in 2006.
Table 3
Descriptive statistics of the independent variables used in the empirical analyses.

| Variables                                      | Expected sign | Fertilisation options (n=524) |
|------------------------------------------------|---------------|-------------------------------|
|                                                |               | no fertilisation (n=43) | manure (n=220) | fertiliser (n=156) | manure + fertiliser (n=105) |
|                                                |               |                             | (n=220)         | (n=156)            | (n=105)                      |
| Socioeconomic characteristics of the sample farm households |               |                             |                |                    |                              |
| zone (1 = MM, 0 = MD sub-areas)                 | +             | 0.21<sup>a</sup>          | 0.55<sup>b</sup> | 0.53<sup>b</sup>  | 0.46<sup>b</sup>            |
| gender (1 = male, 0 = female)                   | ±             | 0.86<sup>ns</sup>         | 0.88<sup>ns</sup> | 0.85<sup>ns</sup> | 0.93<sup>ns</sup>           |
| training (1 = received, 0 = otherwise)         | +             | 0.67<sup>ns</sup>         | 0.56<sup>ns</sup> | 0.53<sup>ns</sup> | 0.66<sup>ns</sup>           |
| off-farm (1 = engaged, 0 = otherwise)          | ±             | 0.35<sup>ns</sup>         | 0.30<sup>ns</sup> | 0.28<sup>ns</sup> | 0.26<sup>ns</sup>           |
| fertiliser (1 = used, 0 = otherwise)           | ±             | 0.00<sup>a</sup>          | 1.00<sup>b</sup> | 1.00<sup>b</sup>  |                              |
| farm (Total farmland holding; ha)              | ±             | 1.76<sup>ab</sup>         | 2.08<sup>ab</sup> | 1.82<sup>a</sup>  | 2.48<sup>b</sup>            |
| livestock (Livestock ownership level; TLU)<sup>b</sup> | +             | 2.47<sup>a</sup>          | 3.42<sup>b</sup> | 2.68<sup>a</sup>  | 4.32<sup>c</sup>            |
| labour (Family and permanent labour force; persons)<sup>c</sup> | ±             | 3.45<sup>ab</sup>         | 3.57<sup>ab</sup> | 3.42<sup>ab</sup> | 3.80<sup>b</sup>            |
| market (Distance from the nearest market centre; km) | ±             | 0.97<sup>a</sup>          | 2.47<sup>b</sup> | 1.74<sup>c</sup>  | 2.41<sup>b</sup>           |
| Biophysical characteristics of the sample farm plots |               |                             |                |                    |                              |
| crop (1 = CMCFs, 0 = OCMFs)                    | +             | 0.91<sup>a</sup>          | 1.00<sup>ab</sup>| 0.02<sup>c</sup>  | 0.00<sup>c</sup>            |
| plotsize (Size of the sample plot; ha)         | ±             | 0.51<sup>a</sup>          | 0.22<sup>b</sup> | 0.39<sup>c</sup>  | 0.39<sup>c</sup>            |
| distance (Distance from the HH house to the plot; m) | ±             | 1453<sup>a</sup>         | 81<sup>b</sup>  | 1402<sup>a</sup> | 790<sup>c</sup>            |
| 0 m < = 100 m<sup>d</sup>                       |               | 5 (12%)                    | 191 (87%)      | 30 (19%)         | 24 (23%)                    |
| 100 m < = 1000 m                                |               | 22 (51%)                   | 28 (13%)       | 67 (43%)         | 52 (50%)                    |
| 1000 m <                                       |               | 16 (37%)                   | 3 (1%)         | 56 (36%)         | 29 (28%)                    |
| Type of the sample plot arada                  |               | 12 (28%)                   | 220 (100%)     | 0 (0%)           | 0 (0%)                      |
| masa                                           |               | 0 (0%)                     | 0 (0%)         | 153 (98%)        | 105 (100%)                  |
| gorba                                          |               | 31 (72%)                   | 0 (0%)         | 3 (2%)           | 0 (0%)                      |

<sup>a</sup> Different superscript letters indicate statistically significant differences between the fertilisation options (P < 0.05). <sup>ns</sup> not significant.

<sup>b</sup> TLU, Tropical livestock unit; livestock (TLU) = cattle ownership level (TLU) × (1 – fuel use rate (%) / 100) + other livestock ownership level (TLU). The fuel use rate indicates what percentage of dung produced by the cattle owned by the sample household was consumed for fuel.

<sup>c</sup> Converted to adult (from 16 to 65 years old) labour force equivalent.

<sup>d</sup> Segments of distance (m).
2. Experimental design, materials and methods

2.1. Study area

Adama and Boset districts in Oromia region, Ethiopia, are classified into five agroecological sub-zones (tef zone, maize zone, semi-pastoral zone, sorghum and tef zone, and wheat and tef zone) [1]. Subsistence crop (sorghum, maize, and barley) and cash crop (tef, wheat, haricot bean, and vegetables) fields are mixed in all zones. The two districts are categorised into mid-altitude dry (MD) sub-area and mid-altitude moist (MM) sub-area in terms of major maize growing areas in Ethiopia [2].

2.2. Sample

The following two-step procedures were used to select sample plots: in the first step, we set a goal to select 150 households from each maize growing sub-area. The target numbers of households were...
Table 6
Average marginal effects of the three multinomial logit models (models B1, B2, and B3).

| Dependent variables | B1 (CMCF subdataset) | B2 (OCMF subdataset) | B3 (pooled dataset) |
|---------------------|----------------------|----------------------|---------------------|
|                     | no fertil- isation   | manure               | fertiliser          | no fertil- isation | manure | fertiliser | manure + fertiliser | no fertil- isation | manure | fertiliser | manure + fertiliser |
| zone                | -0.044               | 0.044                | 0.000              | -0.008             | 0.112*  | -0.104*     | -0.030              | 0.022               | 0.059 | -0.051 |
|                     | (0.754)              | (0.033)              | (1.000)            | (0.018)            | (0.058)  | (0.058)     | (0.020)              | (0.020)             | (0.029) | (0.029) |
| gender              | 0.040                | -0.039               | -0.000             | -0.016             | -0.106* | 0.122       | 0.004               | -0.020             | -0.045 | 0.062 |
|                     | (0.309)              | (0.041)              | (0.999)            | (0.021)            | (0.097)  | (0.097)     | (0.025)              | (0.025)             | (0.050) | (0.049) |
| training            | 0.024                | -0.027               | 0.000              | -0.009             | -0.068* | 0.076       | 0.006               | -0.014             | -0.030 | 0.038 |
|                     | (0.873)              | (0.030)              | (0.999)            | (0.016)            | (0.057)  | (0.056)     | (0.018)              | (0.018)             | (0.029) | (0.028) |
| off-farm            | -0.018               | 0.020                | -0.000             | -0.003             | 0.034    | -0.030      | -0.002              | 0.010               | 0.010  | -0.015 |
|                     | (0.568)              | (0.030)              | (0.998)            | (0.018)            | (0.066)  | (0.065)     | (0.018)              | (0.017)             | (0.033) | (0.033) |
| crop                | not used             | not used             | not used           | not used           | not used | not used    | -0.369              | 0.519               | 1.419  | -1.569 |
|                     | (0.386)              | (38.11)              | (280.25)           | (289.48)           |         |             |                     |                    |                    |        |
| farm                | -0.012               | 0.012                | 0.000              | -0.003             | -0.038*  | 0.042*      | -0.007              | 0.006               | -0.020* | 0.021* |
|                     | (0.146)              | (0.014)              | (1.000)            | (0.007)            | (0.018)  | (0.018)     | (0.008)              | (0.007)             | (0.009) | (0.009) |
| livestock           | -0.024               | 0.024*               | 0.000              | 0.005              | -0.045*  | 0.039*      | -0.009              | 0.012               | -0.023* | 0.019* |
|                     | (0.027)              | (0.008)              | (0.998)            | (0.004)            | (0.012)  | (0.011)     | (0.004)              | (0.007)             | (0.006) | (0.006) |
| labour              | -0.001               | 0.001                | -0.000             | -0.009             | 0.023    | -0.013      | -0.001              | 0.001               | 0.007  | -0.007 |
|                     | (0.198)              | (0.011)              | (0.998)            | (0.009)            | (0.019)  | (0.018)     | (0.006)              | (0.006)             | (0.009) | (0.009) |
| market              | -0.022               | 0.022                | 0.000              | -0.005             | -0.025*  | 0.029*      | -0.014              | 0.011               | -0.012  | 0.015 |
|                     | (0.056)              | (0.012)              | (0.998)            | (0.007)            | (0.015)  | (0.015)     | (0.008)              | (0.008)             | (0.008) | (0.007) |
| plotsize            | 0.130                | -0.131*              | 0.000              | 0.001              | -0.070   | 0.070       | 0.058               | -0.066             | -0.029  | 0.037 |
|                     | (0.391)              | (0.053)              | (0.998)            | (0.058)            | (0.160)  | (0.157)     | (0.031)              | (0.045)             | (0.077) | (0.079) |
| distance            | 0.000                | -0.000***            | 0.000              | 0.000              | -0.000***| 0.000***    | 0.000***             | -0.000***           | 0.000***| -0.000*** |
|                     | (0.000)              | (0.000)              | (0.998)            | (0.000)            | (0.000)  | (0.000)     | (0.000)              | (0.000)             | (0.000) | (0.000) |

Numbers in parentheses are standard error.

* P < 0.1.
** P < 0.05.
*** P < 0.01.
equally split by the number of sub-zones in each sub-area: four and two sub-zones in the MD and MM sub-areas, respectively, and were allocated to each sub-zone. Semi-structured questionnaires were prepared for interviewing randomly selected household heads in November and December 2012. After eliminating questionnaires with invalid data, we had data from 146 and 173 household heads living in the MD and MM sub-areas, respectively. It was found these 146 and 173 household heads had 313 continuous maize cropping fields (CMCFs; 151 for MD and 162 for MM sub-areas) and 302 other than maize cropping fields (OCMFs; 131 for MD and 171 for MM sub-areas). In the second step, we randomly selected 262 CMCFs (131 for MD and 131 for MM sub-areas) and 262 OCMFs (131 for MD and 131 for MM sub-areas) from these 313 CMCFs and 302 OCMFs to match the numbers of the plot data between CMCFs and OCMFs and between MD and MM sub-areas. The total number of the plot data became 524 (262 CMCFs + 262 OCMFs).

2.3. Empirical models

An preliminary field survey conducted in 2011 showed that the CMCFs \(n=262\) had three fertilisation options: (i) no fertilisation \(n=39\), (ii) manure application \(n=220\), and (iii) fertiliser use \(n=3\), while the OCMFs \(n=262\) had three fertilisation options: (i) no fertilisation \(n=4\), (ii) fertiliser use \(n=153\), and (iii) both compost and fertiliser use \(n=105\). The following two empirical exercises were conducted by using different econometric models:

(i) To analyse farmers’ determining factors in binary manure use options (dependent variable, manure: 1 = used, 0 = not used), two binomial logit models were formulated for CMCF and OCMF subdatasets (model A1 and model A2, respectively). Another two binomial logit models were created with and without variable crop (main cropping system to which the sample plot belonged; 1 = CMCFs, 0 = OCMFs) for the pooled dataset (model A3 and model A4, respectively); and

(ii) To assess the farmers’ determinants of four fertilisation options (dependent variable, fertilisation: 1 = no fertilisation, 2 = manure application, 3 = fertiliser use, 4 = both manure and fertiliser use), two multinomial logit models were built for the CMCF and OCMF subdatasets (model B1 and model B2, respectively). Another two multinomial logit models were formulated with variable crop (model B3) and without variable crop (model B4) for the pooled dataset. Hausman test or Small-Hsiao test [3] was conducted to verify the independence of irrelevant alternatives (IIA) hypothesis.

Independent variables selected in this study were based upon the literature on technology adoption studies of manure/fertiliser use (Tables 1 and 3). To select appropriate models for further analyses, indicators of the optimum model selection for logit models [4] including the log-likelihood, McFadden’s pseudo-\(R^2\), Akaike’s information criterion (AIC), Bayesian information criterion (BIC), and the % correctly estimated values were examined. To test the validity of the subsampling method, the sum of squared residuals obtained from the pooled dataset and subdatasets to test the equality of coefficients were compared between the models [5]. Stata 13.0 (StataCorp LP) was used for the empirical calculations.

2.4. Logit analyses

Summary statistics (Table 4) showed the indicators of the optimum model selection for logit models and the sum of squared residuals (SSR) obtained from the four binomial logit models (A1, A2, A3, and A4) and four multinomial logit models (B1, B2, B3, and B4). The binomial logit and multinomial logit analyses were shown in Tables 5 and 6, respectively.

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References

[1] ICRA, Livelihood and Drought Coping Strategies of Farm Households in the Central Rift Valley, Ethiopia: Challenges for Agricultural Research, International Center for Development Oriented Research in Agriculture, Wageningen, 1999.
[2] S. Twumasi-Afriyie, H. Zelleke, K. Yihun, B. Asefa, S. Tariku, Development and improvement of highland maize in Ethiopia, in: M. Nigussie, D. Tanner, S. Twumasi-Afriyie (Eds.), Enhancing the Contribution of Maize to Food Security in Ethiopia, EARO and CYMMIT, Addis Ababa, 2002, pp. 31–38.
[3] J. Freese, J.S. Long, Regression Models for Categorical Dependent Variables Using Stata, first ed., Stata Press, College Station, 2001.
[4] A.C. Cameron, P.K. Trivedi, Microeconometrics: Methods and Applications, Cambridge University Press, New York, 2005.
[5] J.M. Wooldridge, Introductory Economics: A Modern Approach, fourth ed., South-Western Cengage Learning, Mason, 2009.
[6] J. Somda, A.J. Nianogo, S. Nassa, S. Sanou, Soil fertility management and socio-economic factors in crop-livestock systems in Burkina Faso: a case study of composting technology, Ecol. Econ. 43 (2002) 175–183.
[7] T.S. Mkhabela, S.A. Materechera, Factors influencing the utilization of cattle and chicken manure for soil fertility management by farmers in the moist midlands of KwaZulu-Natal province, South Africa, Nutr. Cycl. Agroecosyst. 65 (2003) 151–162.
[8] J.N. Chianu, H. Tsuji, V.M. Manyong, Crop-livestock interaction in the savannas of Nigeria: nature and determinants of farmer decision to use manure for soil fertility maintenance, J. Food Agric. Environ. 5 (2007) 295–301.
[9] M. Kassie, P. Zikhal, K. Manjur, S. Edwards, Adoption of sustainable agriculture practices: evidence from a semi-arid region of Ethiopia, Nat. Resour. Forum 33 (2009) 189–198.
[10] F.N. Emuh, A.U. Ofooku, Analysis of the adoption of farm yard manure among small-scale farmers in Delta state, Nigeria, Int. J. Sci. Nat. 2 (2011) 813–820.
[11] O.I. Ayuya, W.S. Kenneth, G.O. Eric, Multinomial logit analysis of small-scale farmers’ choice of organic soil management practices in Bungoma county, Kenya, Curr. Res. J. Soc. Sci. 4 (2012) 314–322.
[12] M. Belay, W. Bewket, Farmers’ livelihood assets and adoption of sustainable land management practices in northwestern highlands of Ethiopia, Int. J. Environ. Stud. 70 (2013) 284–301.
[13] A.T. Terefe, M.H. Ahmed, G.G. Gebremariam, Adoption and extent of use of organic fertiliser in Arsi Negelle district, Oromia regional state of Ethiopia: what are the sources? Adv. J. Agric. Res. 1 (2013) 61–71.
[14] S. Makokha, S. Kimani, W. Mwangi, H. Verkuil, F. Musembi, Determinants of Fertiliser and Manure Use in Maize Production in Kiambu District, Kenya, CIMMYT and KARI, Mexico, 2001.
[15] D. Bacha, A. Girma, G. Abdissa, D.G. Hugo, The determinants of fertiliser and manure use in maize production in Western Oromiya, Ethiopia, in: D.K. Friesen, A.F.E. Palmer (Eds.), Integrated Approaches to Higher Maize Productivity in the New Millennium, CIMMYT and KARI, Nairobi, 2002, pp. 438–441.
[16] W.A. Oluoch-Kosura, P. Phiri Marenya, M.J. Nzuma, Soil fertility management in maize-based production systems in Kenya: current options and future strategies, in: D.K. Friesen, A.F.E. Palmer (Eds.), Integrated Approaches to Higher Maize Productivity in the New Millennium, CIMMYT and KARI, Nairobi, 2004, pp. 350–355.
[17] T. Abdoulaye, J.H. Sanders, Stages and determinants of fertiliser use in semiarid African agriculture: the Nigerian experience, Agric. Econ. 32 (2005) 167–179.
[18] P.B. Birungi, The linkages between land degradation, poverty and social capital in Uganda (Ph.D. dissertation), University of Pretoria, 2007.
[19] P.P. Marenya, C.B. Barrett, Household level determinants of adoption of improved natural resources management practices among smallholder farmers in western Kenya, Food Policy 32 (2007) 515–536.
[20] M.M. Waithaka, P.K. Thornton, K.D. Shepherd, N.N. Ndiwa, Factors affecting the use of fertilisers and manure by smallholders: the case of Vihiga, western Kenya, Nutr. Cycl. Agroecosyst. 78 (2007) 211–224.
[21] A.A. Akinola, R. Adeyemo, A.D. Alene, Determinants of adoption of balanced nutrient management systems technologies in the Northern Guinea Savanna of Nigeria: a multinomial logit approach, Int. J. Agric. Econ. Rural Dev. 4 (2011) 53–64.
[22] M. Ketema, S. Bauer, Determinants of manure and fertiliser applications in eastern highlands of Ethiopia, Q. J. Int. Agric. 50 (2011) 237–252.
[23] M.T. Zeleke, Y. Abera, Determinants of the adoption of land management strategies against climate change in Northwest Ethiopia, Ethiop. Renaiss. J. Soc. Sci. Humanit. 1 (2014) 93–118.