SI Table 1: Farmland earthworm survey results 2017. Tillage description was provided by the farmer. Presence is the detection in soil pit (n = 5, 20 cm x 20 cm x 20 cm size) calculated as a percentage. Only mature (clitellate) earthworms could be identified to ecological group level.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Field number | Tillage (arable)  | Earthworm presence (%) | Epigeic presence (%) | Endogeic presence (%) | Anecic presence (%) | Middens per m2 | Earthworm (millions ha-1) |
| 1 | Min-Till | 80 | 0 | 40 | 0 | 0 | 0.69 |
| 2 | Zero Till  | 100 | 20 | 40 | 0 | <15 | 1.2 |
| 3 | Direct drill | 100 | 40 | 40 | 20 | <15 | 2.1 |
| 4 | Plough | 100 | 0 | 40 | 0 | 0 | 1.5 |
| 5 | Strip till | 100 | 0 | 80 | 40 | 0 | 1.7 |
| 6 | Strip till | 100 | 0 | 60 | 20 | 0 | 2.1 |
| 7 | Strip till | 100 | 0 | 100 | 40 | 0 | 2.8 |
| 8 | Min Till | 100 | 0 | 100 | 40 | 0 | 2.3 |
| 9 | Direct drill | 100 | 0 | 100 | 20 | 0 | 2.9 |
| 10 | Direct drill | 100 | 40 | 100 | 40 | <15 | 2.9 |
| 11 | Direct drill | 100 | 0 | 100 | 40 | <15 | 3.6 |
| 12 | Plough | 100 | 0 | 80 | 80 | 0 | 3.6 |
| 13 | Min Till | 100 | 20 | 80 | 40 | <15 | 2.4 |
| 14 | Direct drill | 100 | 60 | 100 | 40 | <15 | 4.1 |
| 15 | Min Till | 100 | 40 | 80 | 40 | >15 | 6.4 |
| 16 | Zero till | 100 | 40 | 60 | 40 | <15 | 2.0 |

|  |  |  |  |
| --- | --- | --- | --- |
| Pesticide (active ingredient) | Section | Strip treatment | Concentration (mg kg-1) |
| Epoxiconazole | 1 | FYM N3 | 0.22 – 0.23 |
|  | 1 | NIL | 0.15 – 0.17 |
|  | 1 | N1+2+1PKMg | 0.13 – 0.26 |
| Tebuconazole | 1 | FYM N3 | 0.06 – 0.07 |
|  | 1 | NIL | 0.08 – 0.09 |
|  | 1 | N1+2+1PKMg | 0.10 – 0.17 |
| Aldrin/Dieldrin | 1 | FYM N3 | 0.012 – 0.014 |
| (previous use) | 1 | NIL | 0.003 – 0.003 |
| Pendimethlin | 1 | FYM N3 | 0.018 – 0.019 |
|  | 1 | NIL | 0.016 – 0.019 |
|  | 1 | N1+2+1PKMg | 0.011 – 0.016 |
|  | 6 | FYM N3 | 0.016 – 0.020 |
| Boscalid | 1 | FYM N3 | 0.06 – 0.07 |
|  | 1 | NIL | 0.02 – 0.03 |
|  | 1 | N1+2+1PKMg | 0.04 – 0.05 |
| Clothianidin | 1 | FYM N3 | 0.01 |
| Prosulfocarb | 1 | NIL | 0.02 |
|  | 1 | N1+2+1PKMg | 0 – 0.02 |
|  | 6 | FYM N3 | 0 – 0.01 |
| Pyraclostrobin | 1 | N1+2+1PKMg | 0 - 0.02 |

SI Table 2. Pesticides detected in the Broadbalk soils

|  |  |
| --- | --- |
| Pesticide | Concentration (mg kg-1) |
| Epoxiconazole | 0.4 |
| Tebuconazole | 2 |
| Fluxapyroxad | 0.4 |
| Pyraclostrobin | 0.05 |
| Isopyrazam  | 0.05 |

SI Table 3.Pesticides detected in wheat straw harvested from the Broadbalk Experiment, Section 1, on which straw is retained.

**SI Table 4** . Scientists opinions relating to the farmland earthworm survey and its usefulness to scientists, compared to recommendations to farmers and policy makers for soil health monitoring.

|  |  |  |  |
| --- | --- | --- | --- |
| **Usefulness to scientists** | **Would you recommend this activity for farmland soil health monitoring to farmers?** | **Would you recommend this activity for farmland soil health monitoring to policy makers?** | **Comments** |
| Extremely useful | Yes | Yes | I think a short fixed sampling window is good. We know earthworms are sensitive to temp and moisture, even a few dry days can change what you find. Not sure if this is recorded in the survey e.g. conditions |
| Extremely useful | Yes | No | Good Job! |
| Very useful | Yes | Yes |  |
| Very useful | Yes | Yes | Maybe quality control by scientists going to random farmer return field to check data would help validate the results |
| Useful | Yes | No | As a guide for farmers to help them think about soils and their management this is great. I'm not convinced it should be part of policy (e.g. like the soil testing under the 'Rules for water' requirements). |
| Useful | No | No |  |
| Useful | Yes | No |  |
| Useful | Yes | Yes | I would recommend this activity for farmland soil health monitoring but it would need substantial revisions in order to fully understand the impacts of agriculture have on worm populations. |
| Slightly useful | Yes | Yes | - |
| Slightly useful | Yes | Yes | - |
| Slightly useful | Yes | No | - |
| Slightly useful | No | No | At the moment I'm not convinced that earthworms are the best monitor due to various work done looking at controls on earthworm distribution which usually finds patchy distributions with no obvious driver of those that the level of variation in earthworm numbers between pits isn't so large as to make interpretation of surveys based on a few pits useful. One could get lucky and have five earthworm pits but as far as I can tell from the literature data another five puts could yield no earthworms. So I do think that the presence of earthworms is a good sign in soil but I also think that the patchiness of earthworm distributions is a challenge to using them as soil health indicators and that this needs to be fully understood before they could be recommended to policy makers and farmers - largely because usually you only get one shot at it. |
| Not at all useful | Yes | Yes | - |