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Article

Sowing and Harvesting Measures to Cope with Challenges of Cover Crops Experienced by Finnish Farmers

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Abstract: Farmers may promote the cultivation of under-sown cover crops (CCs) in various ways without jeopardizing the yield of a cash crop. With this survey, we aimed to understand how Finnish farmers manage possible challenges with under-sown CCs. A farmer survey was carried out in 2021. We invited 6493 farmers who had selected CCs as a registered measure to answer a questionnaire with 20 statements (a Likert scale), and 1130 responded (17.4%). A Cochran–Mantel–Haenszel test was used to measure the strength of the association between 11 farm/farmer characteristics of the respondents and 20 statements. Responses indicated that farmers often took under-sown CCs into account during the growing season. Sowing was considered an especially critical measure and the CC seeding rate was often assessed with a test run before sowing. Thirty-nine per cent of the respondents had made investments, most often to facilitate sowing. The farmers usually adjusted the fertilizer rate only according to the cash crop. Early harvesting of a cash crop was considered important by 58% of farmers to ensure that the CCs do not hamper the harvest. Farmers harvested cash crops as soon as they matured and were harvestable, though they had mixed views on whether CCs impacted the quality of the cash crop. Subsidized, investing farmers were likely to be oriented towards the benefits from the ecosystem services provided by CCs. Their experiences should be shared among the farming community to support the large-scale implementation of CCs.

Keywords: cover crops; crop management; harvesting; investment; sowing; survey

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1. Introduction

Cover crops (CCs) represent an important, though underutilized, potential to contribute to the sustainability of agricultural systems by providing a high number of ecosystem services [1–4]. Farmers' adoption of CCs has not been primarily driven by the benefits provided by CCs per se, and agricultural policy has been found to be the strongest determinant of adoption rates and intensities in the European Union (EU) [5]. Adoption rates have varied depending on the region and in general have been low in the EU. Interest towards CCs has continued to grow in Finland since the first report highlighting such a trend [6]. In addition to differences in existing subsidies available for farmers, regional differences in farm adoption intensities [5] may be attributable to the lack of region-specific knowledge and experiences of the cultivation of CCs, especially considering the local conditions and challenges. This is not least because success in cultivation and the potential benefits of CCs are highly dependent on conditions [7].

Recent research initiatives have expanded our understanding on the cultivation of CCs depending on the region. Decision support systems have been developed to provide further support for farmers [8–10]. Lamichhane and Alletto [11] published a research road map of cover crops, in which they highlighted current knowledge gaps impeding the realization of potential ecosystem services which could be provided by CCs. Furthermore, they proposed six research priorities to bridge the current knowledge gaps in defining, managing, and utilizing CCs. Key reasons leading to the current gap include: (1) lack of appropriate selection of CCs, poor seed quality, and limited market availability, (2) poor establishment quality and insufficient biomass production of CCs, as well as (3) inappropriate or nonoptimal management and utilization of CCs [11].

This study is part of a large farmer survey carried out in Finland with a focus on CCs, that are usually sown in spring, but also in autumn, to provide an over-wintering green biomass. We have concluded so far that farmers value various benefits provided by CCs for the environment and production system [12]. Furthermore, farmers allocated CCs to field parcels that were next to waterways, and conventional farmers allocated them on large parcels with a history of cereal monoculture [13]. It was also found that farmers had gained expertise with a surprisingly high number of CCs [14] when considering how the climate in Finland, in general, limits crop production [15,16]. Conservation agriculture combines zero tillage [17] with the use of CCs and diverse crop rotations. Such a combination is not, however, common in Finland, where zero tillage is primarily used in fields with cereal monocultures [18]. With this study we gathered experiences considering the potential challenges faced by Finnish farmers considering impressions related to seed availability, the establishment of CC-stands, and harvesting. Thereby, with this survey we aimed to gain an understanding of the challenges farmers face in the cultivation of CCs, how they have overcome these via basic management practices during the growing season, and whether they have invested in special machinery and equipment to make the cultivation of CCs more successful.

2. Materials and Methods

A farmer survey was carried out in Finland in spring 2021 with the aim to collect hidden, up-to-date information about farmers' views, experiences, and motives for cultivation of CCs to support transition towards extensive use. The sought set of respondents were organic and conventional farmers who had applied for CC subsidy payments in 2020. The subsidies were registered on the field parcel scale. In total, requested details of 7025 farms (16% of Finnish farms in 2021) were obtained from the registry of the Finnish Food Authority (FFA). These included farm identification numbers, farm types, locations, and the farmers' email-addresses. A total of 6493 farmers were invited to participate in the survey, and they were contacted by email. The number of invitees was less than the full list of farms obtained from the FFA, because a farmer may own several farms (and only one invitation was sent), and some of the farmers had no email address as contact information. In total, 1130 farmers answered the survey, which corresponded to a 17.4% response rate.

The survey started on 16 March 2021 and ended on 11th April 2021. Both official languages, Finnish and Swedish, were available for the participants to choose from. One reminder message was sent on 30th March 2021. The questionnaire was large, and some subject areas have already been published [12,13,19]. This paper is based on data gained from 11 statements under the general question "What do you think about the following statements concerning the cultivation of CCs?" and another eight statements under the general question of "How do you act with CCs?". The statements reported here concerned potential down-to-earth challenges faced by farmers and measures concerning seed availability, sowing, harvesting, and quality impacts. The respondent farmers were also asked about possible investments with the statement "I have invested in special machinery to make cultivation of CCs more successful". Furthermore, farmers were given an opportunity to describe their investments (machine and/or reason) in their own words, and 435 farmers (i.e., 39% of all respondents) used this opportunity. The survey respondents were requested to answer all the questions in the survey to be able to return their answers. According to the preliminary examination, the answers of all the 1130 respondents were considered acceptable and were used for statistical analyses.

The statistical analyses began by grouping the respondents according to: (1) the farming system (organic and conventional), (2) farm type [cereal, specialized crop production (e.g., oilseed rape, grain legumes, caraway (*Carum carvi* L.), potatoes (*Solanum tuberosum* L.) and sugar beet (*Beta vulgaris* var. *altissima*), horticulture, cattle, pig, poultry and horse/sheep farm], (3) the farm size (<40, 40–79, 80–119 and ≥120 ha), (4) geographical region (South, West, East/North Finland and the inland region), (5) the farmers' ages (≤50 and >50 years), (6) education (basic, vocational, college level and university education), (7) share of cereal area on the farm (<25%, 25–50% and ≥50%), (8) share of grassland area on the farm (<25%, 25–50% and ≥50%), (9) share of area of other crops (e.g., potatoes and sugar beet) on the farm (<25%, 25–50% and ≥50%), (10) share of special crop area (e.g., rapeseed and grain legumes) on the farm (0%, <10% and ≥10%, and (11) the number of CC-species that the farmer was experienced with (1–5, 6–10 and ≥11 CCs). The most common CCs used by farmers were Italian ryegrass (*Lolium multiflorum* L.), timothy (*Phleum pratense* L.), white clover (*Trifolium repens* L.), red clover (*T. pratense* L.), oats (*Avena sativa* L.) and meadow fescue (*Festuca pratensis* L.) [14]. These were used as under-sown, catch, and break CCs to provide an over-winter biomass that is preferably naturally terminated by harsh winter conditions and if not, then mechanically. More details on the grouping and data sources are available in [12]. Some non-response bias was found when the characteristics of the respondents who returned the survey were compared to those of the non-respondents [12]. In such cases weights are used to bring the sample and the population more in line. This 'non-response weighting' was considered in the statistical analysis. However, such weights were needed only for a few respondents and hence, the total effect remained marginal, if any, and therefore this procedure was not used. A schematic presentation of the data processing has been published [12]. A Cochran–Mantel–Haenszel test (CMH) was used to test the relationship between the row and column variables. The row variables were formed from 11 characteristics of the respondents and the column variables were the results of the 20 statements with responses indicated on a 5-point Likert scale. The only exception was the statement "I have invested in special machinery to make the cultivation of CCs more successful" which used a 3-point Likert scale ("often", "occasionally" or "seldom or never"). Typically, both variables were ordinal scales and "the correlation statistic" of the CMH with 1 degree of freedom was used. If a row variable was not an ordinal scale (region and farm type), the ANOVA (Row Mean Scores, RMS) statistic for the CMH was used. ANOVA (RMS) tests were used for all pairwise comparisons, as well as when testing the interaction between the farming system and other characteristics of the respondents. This study was focused on farmers with experience of CCs and hence, no control group of unexperienced farmers was used. All CMH tests were performed using SAS/FREQ and SAS/GLM procedures.

The number of CCs that a farmer experienced was defined as:

$$y_i = \sum_{k=1}^{28} I_{ij} \tag{1}$$

where i refers to the respondent (i = 1, . . . , N), while y_i is a new variable that defines the experience of a respondent i. The experience of each respondent is calculated based on 28 CC-species (k refers to a species, k = 1, . . . , 28) and y_i is calculated as the sum of zeros and ones so that the binary variable I_{ij} is 1 if a respondent i has answered to have either "somewhat", "plenty" or "very much" experience with CC-species k. Otherwise, a zero is added to the sum of the corresponding y_i. For the statistical analysis, the number of CCs that the farmers had experience with were classified into three groups (1–5, 6–10 and ≥11 CCs). After that, all statistical analyses were based on the CMH and ANOVA tests.

3. Results

3.1. Farmers' Views on Potential Weak Links in the Cultivation of CCs

Seventy-one per cent of farmers agreed that the availability of CC seeds was not a bottleneck, whereas 13% of respondents experienced it as a problem (Figure 1). Farmers with horticultural farms disagreed the most (Figure S1). On the other hand, 62% of farmers considered that unconventional CC seeds were expensive compared to risk of failure, while only 9% disagreed (Figure 1): aged farmers (>50 years) were slightly more concerned (66% agreed) than younger ones (58%) (Figure 2). Forty-five per cent of the respondents agreed and 27% disagreed that CC seeds were expensive compared to the benefits gained from their cultivation. Especially farmers with <80 ha farm size found the seeds expensive compared to the benefits (Figure 3), as did less educated farmers when compared to those with a university degree (Figure 4).

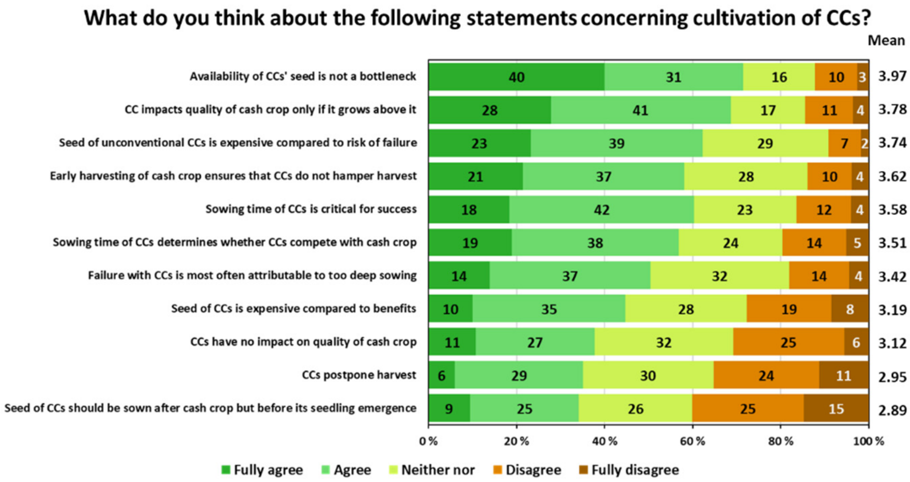

Figure 1. The distribution and mean (in order of decreasing value) of the farmers' answers (N = 1130) to the principal question: "What do you think about the following statements concerning the cultivation of cover crops (CCs)?". The answer choices were: "1 = fully disagree, 2 = disagree, 3 = neither agree nor disagree, 4 = agree and 5 = fully agree". The share of each answer choice (%) is shown within each bar.

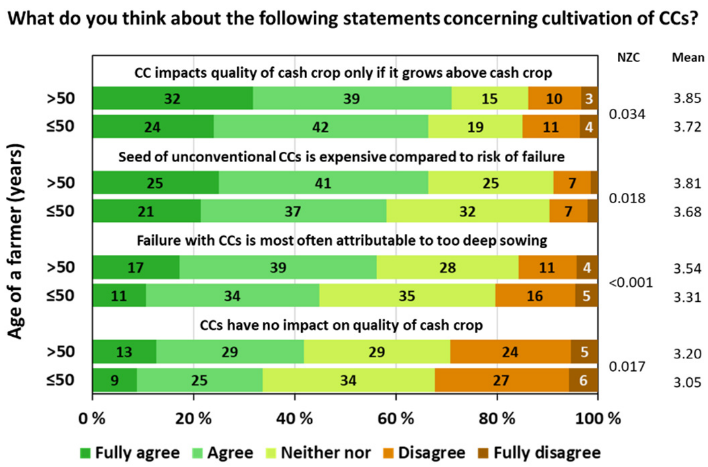

Figure 2. The distribution of farmers' answers (N = 1130) depending on the farmer's age (NZC, nonzero correlation; CCs, cover crops). The share of each answer choice (%) is shown within each bar. Means with the same letter do not differ significantly from each other (at $p \leq 0.05$).

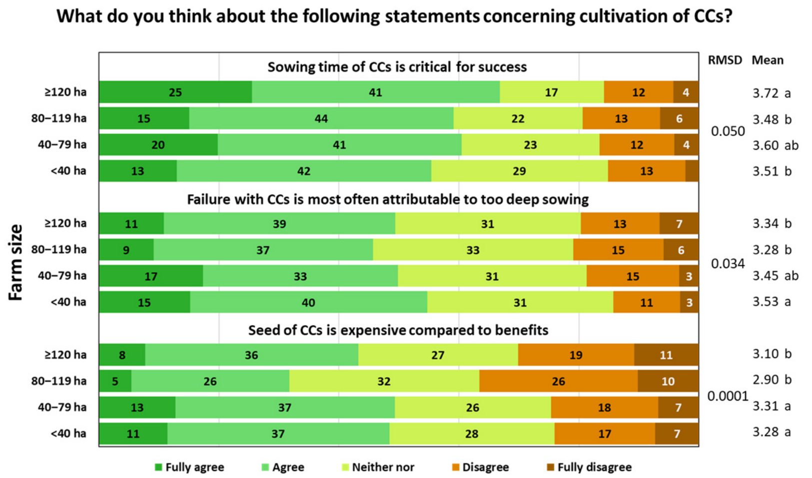

Figure 3. The distribution of farmers' answers (N = 1130) depending on the farm size (RMSD, row mean scores difference; CCs, cover crops).

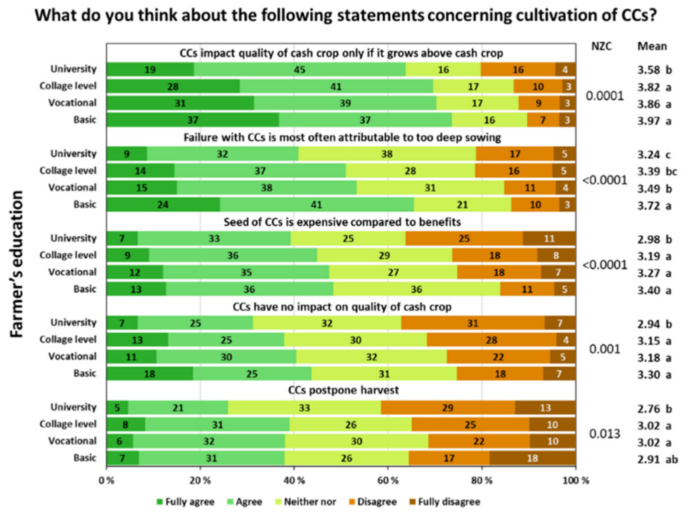

Figure 4. The distribution of farmers' answers (N = 1130) depending on the farmer's education (NZC, nonzero correlation; CCs, cover crops).

In addition, 60% of the respondents agreed and 16% disagreed that the sowing time was critical for success with CCs (Figure 1). This statement was supported more frequently in the case that farm was very large (66%) and located in South Finland (66%), it was in organic production (66%), it had a low area under grassland (65%) or a high area was used for special crops (66%), while less frequently in the case of horse/sheep, horticulture, and cattle farms (Figures 3, 5, 6, S1 and S2). The sowing time was considered to determine whether CCs competed with the cash crop by 57% of respondents (Figure 1) and more frequently in the case of organic farmers (66%), while this was reported least often by horticulture farms (28%) (Figures 6 and S1). The failure of CCs was agreed to be attributable to overly deep sowing by 51% of respondents (Figure 1), and more so by aged farmers and those with less education or those who had small farms (Figures 2–4). Furthermore, farmers who did not cultivate special crops tended to agree more frequently with this statement (Figure S2). However, the farming system × special crop area interaction was significant (p-value 0.041) and only the answers from organic farmers differed (p-value 0.004) depending on the special crop area: organic farmers agreed less often that failure was attributable to deep sowing in the case that they had higher field areas under special crops (data no shown). Farmers agreed least often (34% agreed, 40% disagreed) of all with the statements that the seeds of CCs should be sown after the cash crop but before seedling emergence (Figure 1). Conventional farmers agreed less frequently (31%) than organic producers (43%) on this topic (Figure 6).

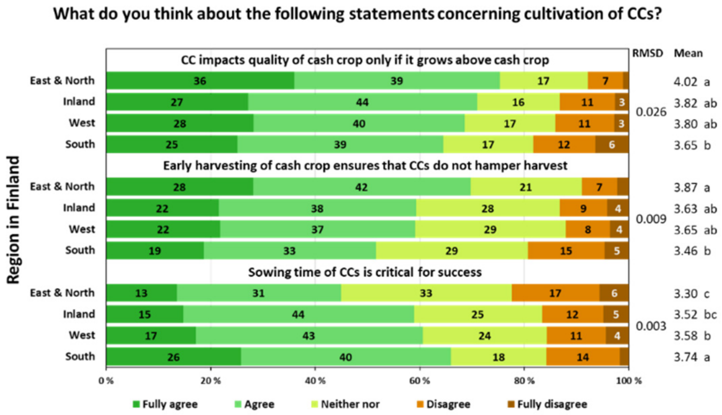

Figure 5. The distribution of farmers' answers (N = 1130) depending on the region in Finland (RMSD, row mean scores difference; CCs, cover crops).

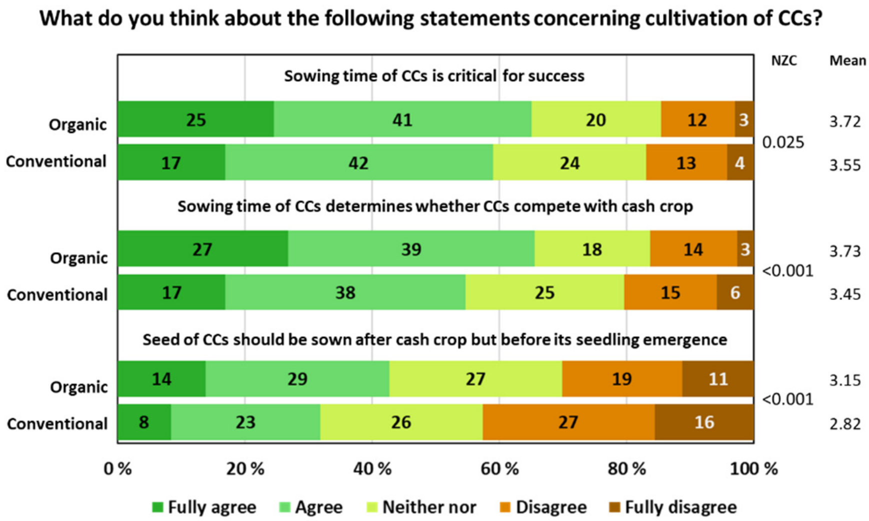

Figure 6. The distribution of farmers' answers (N = 1130) depending on the farming system (NZC, nonzero correlation; CCs, cover crops).

With regards to whether the early harvesting of cash crops ensures that CCs do not hamper the harvest, 58% of respondents agreed and only 14% disagreed (Figure 1). Farmers in East/North Finland agreed more frequently than those in South Finland (Figure 5). Furthermore, 35% of farmers agreed and another 35% disagreed that CCs delayed the harvest (Figure 1). Farmers with experience of growing special crops agreed less frequently (Figure S2) as did those with a higher education (Figure 4).

In terms of whether CCs had no impact, negative or positive, on the quality of the cash crop, 38% of respondents agreed (31% disagreed) (Figure 1). Furthermore, 69% of farmers agreed that CCs had impacts on quality only if they grow above the cash crop: farmers in East/North Finland agreed more frequently than those in South Finland (Figure 5). Older and less educated farmers agreed more frequently on these statements on the CCs' quality impacts than younger and university educated farmers did (Figures 2 and 4).

3.2. Farmers' Cultivation Practices with CCs

The most common CCs used by farmers were Italian ryegrass, timothy, white clover, red clover, oats, and meadow fescue. As these are very common species in Finland, the vast majority of farmers neither produce farm-saved CC seeds or purchase them from abroad (82% and 89% answered seldom/never, respectively) (Figure 7). Some farmers had experience with special CCs such as lucerne (*Medicago sativa* L.), phacelia (*Phacelia tanacetifolia* L.), sweet clover (*Melilotus alba* L.), crimson clover (*T. incarnatum* L.), common bird's-foot trefoil (*Lotus corniculatus* L.), black medick (*M. lupulina* L.), and sickle medick (*M. falcata* L.) [14]. Hence, the respondents who reported that they purchased CC seeds often or always from abroad (3% of respondents) or did so occasionally (8%) were likely those having rarely used CCs. On the other hand, 3% always produced farm-saved seeds, 6% did so often and 9% occasionally. Seeds were imported slightly more frequently in the case that the farm had ≥80 ha field area, it was located in South Finland, it was in organic production (Figures 8–10), the cereal area was low, other crop areas high and/or the farmer was experienced with special crops (Figures S3–S5), the farmer was ≤50 years old and highly educated (Figures S6 and S7) and he/she cultivated a high number (≥11) of CC-species (Figure 11). Findings on differences between farm and farmer characteristic were often parallel with import and on-farm production of CC seeds. In addition, cereal farms produced farm-saved seeds of CCs more often than cattle farms (Figure S8).

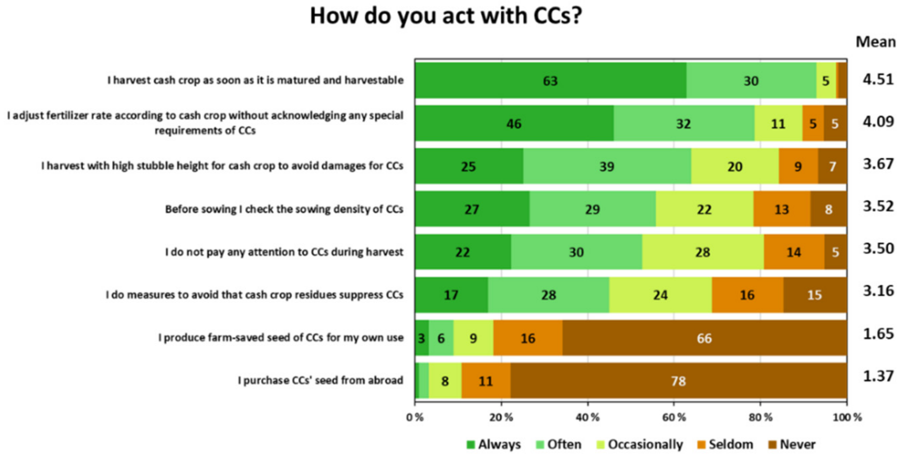

Figure 7. The distribution and mean (in order of decreasing value) of the farmers' answers (N = 1130) to the principal question: "How often do you act with cover crops (CCs)?". The answer choices were: "1 = never, 2 = seldom, 3 = occasionally, 4 = often and 5 = always". The share of each answer choice (%) is shown within each bar unless it was <3%.

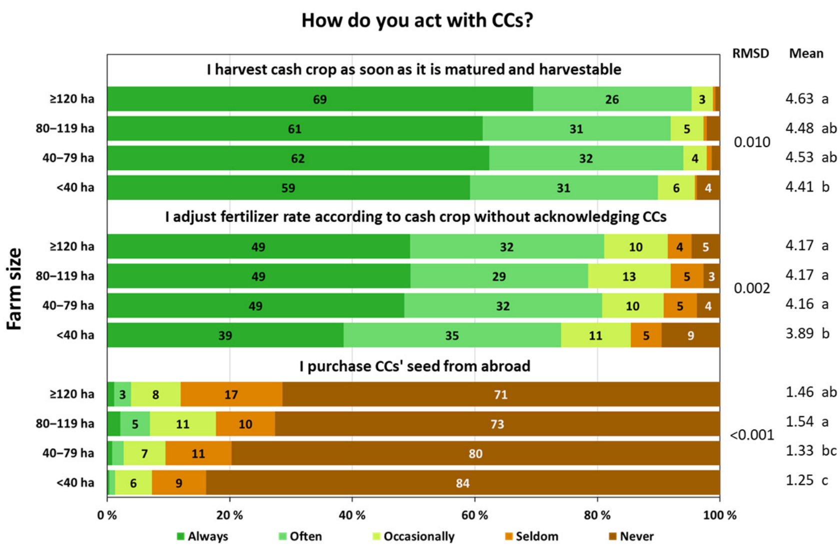

Figure 8. The distribution of farmers' answers (N = 1130) depending on the farm size (RMSD, row mean scores difference; CCs, cover crops).

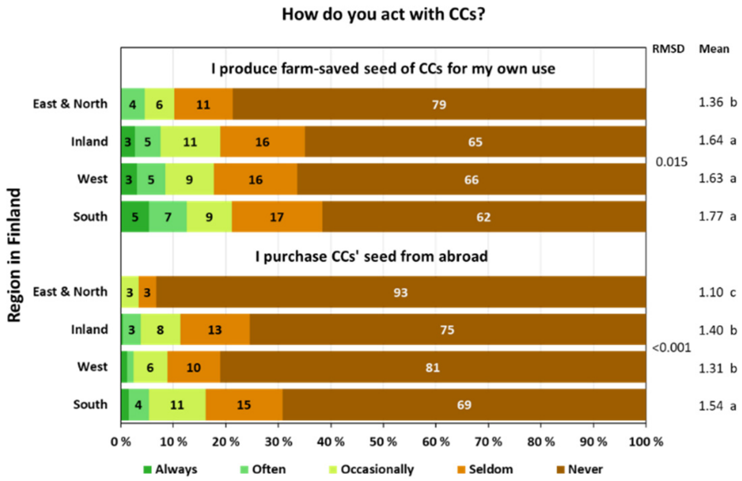

Figure 9. The distribution of farmers' answers (N = 1130) depending on the region in Finland (RMSD, row mean scores difference; CCs, cover crops).

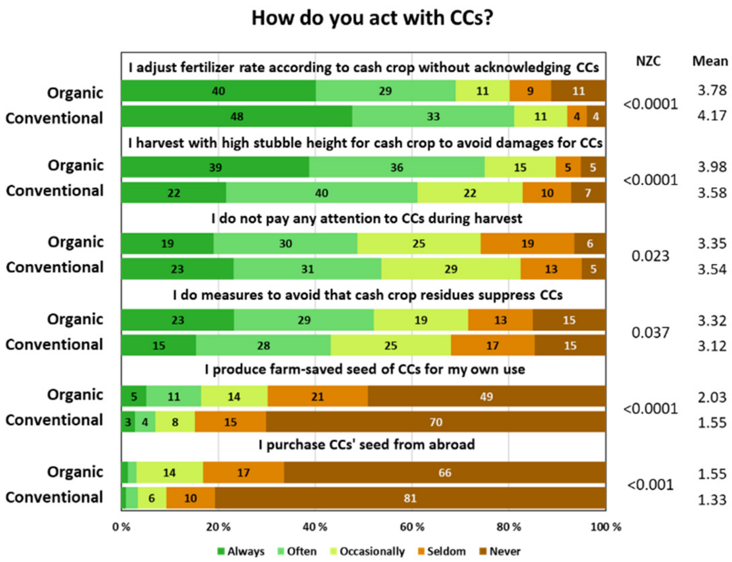

Figure 10. The distribution of farmers' answers (N = 1130) depending on the farming system (NZC, nonzero correlation; CCs, cover crops).

Only 8% of farmers answered that they never checked the sowing density of CCs beforehand and 13% made a test run seldom, while 56% checked it always or often (Figure 7). No differences were found between farm and farmers characteristics except for farmers who had experience of a higher number of CCs (≥11) checked the sowing density more frequently that those with 1–5 CC species (Figure 11). Farmers who checked the sowing density of CCs more frequently agreed more often that the sowing time of CCs was critical for success, and it determines whether CCs compete with cash crops, and that the failure of CCs was most often attributable to deep sowing (Figure S9).

The majority of farmers adjusted their fertilizer use according to the cash crop without considering the requirements or impacts of the CC on the cash crop nutrition: 46% of respondents did so always and 32% often (Figure 7). The respondent farmers agreed with this statement more frequently in the case of ≥40 ha farm size (Figure 8), they were conventional producers (Figure 10), they had a cattle or pig farm (Figure S8), they had a low area of grassland or other crops, while they had a high area of cereals on the farm (Figures S3, S5 and S10), they were experienced with a lower number of CC species (Figure 11), and they had a higher than basic education (Figure S7). The farming system × farm size interaction was significant (p-value 0.038) for the statement on fertilizer use:

conventional farmers did not differ depending on the farm size (p-value 0.237) in contrast to organic farmers (p-value < 0.001) who agreed more frequently that they applied fertilizer according to the cash crop only in the case of a higher farm size (data not shown).

Figure 7 shows that 93% of farmers harvested cash crops as soon as they matured and were harvestable. Despite a high total share of always- (63%) and often-answers (30%), the share was higher when the farmer had a very large farm rather than a small farm (Figure 8), and in the case of a high area allocated to cereals, while a low area allocated to grassland and other crops (Figures S3–S5 and S10). The farmers' readiness to harvest cash crop as soon as possible differed significantly between the following farm types: in descending order of cereal farms → special crop and cattle farms → horticulture farms (Figure S8). Most farmers acknowledged CCs during harvest: 64% of respondents answered that they harvested cash crops always or often at a high stubble height to avoid damage to CCs, and 45% of famers said they took measures to avoid cash crop residues suppressing CCs (Figure 7). High stubble was more frequently used during harvesting by organic than conventional producers, farmers who had cereal farms than those with special crops, horticulture, and pig farms, farmers who were experienced with a higher number of CCs, were less educated and >50 years old (Figures 10, 11 and S6–S8). Farmers who were organic producers, had a higher share of grassland area, no expertise in cultivation of special crops, expertise with higher number of CC-species, and who were >50 years old and less educated applied measures more frequently to avoid the suppression of CC growth caused by cash crop residues (Figures 10, 11, S4, S6, S7 and S10).

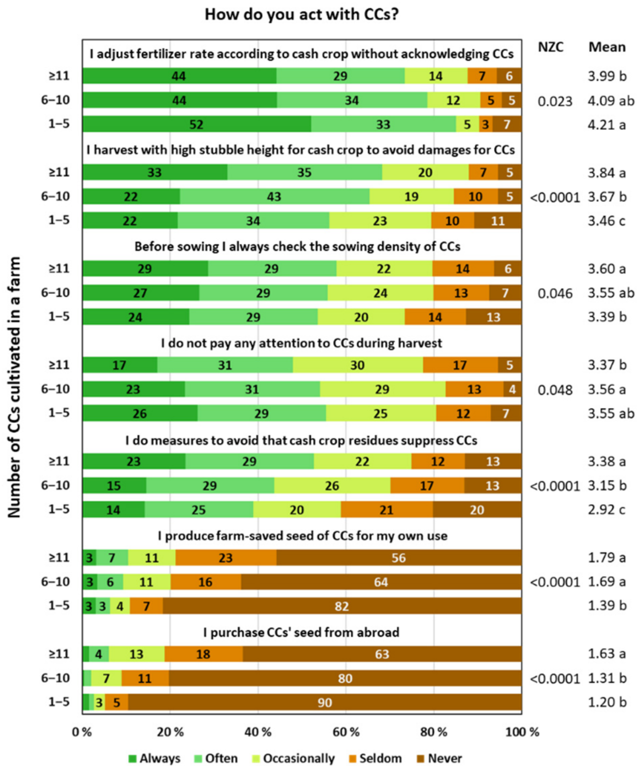

Figure 11. The distribution of farmers' answers (N = 1130) depending on the number of cultivated cover crops (CCs) on the farm (NZC, nonzero correlation).

3.3. Farmers' Investments in Special Machinery and Equipment

When the respondent farmers were asked if they had invested in special machinery or equipment to make the cultivation of CCs more successful, 29% answered that they had done so often, 15% occasionally, while 56% reported they had done so seldom/never (Figure 12). Farmers who were experienced in cultivating a higher number of CC species had made more investments as had those with farms in South Finland. Farmers had invested more frequently also in the case of a larger farm size and lower share of field area allocated as grassland. Organic producers, farmers with experience in the cultivation of special crops, and those who were more educated and ≤50 years old tended to invest more. Considering the farm types, horticulture and cattle farms invested least often contrary to poultry, pig, cereal, and special crop farms (in descending order).

In addition, 44% of respondents had invested in special machinery or equipment often or occasionally (Figure 12) and 39% of all respondents provided free-word specifications (i.e., 89% of those who invested). The majority of the investments were made to improve the success of sowing. Most often (≥29% of those who had invested) farmers reported that they had purchased a sowing unit for small seeds that was used to enable the simultaneous sowing of CCs with a cash crop, and to enable better conditions for CC germination and seedling emergence (Figure 13). In general, farmers who had higher shares of grasslands tended to invest less frequently than those with cereals and other seed crops (data not shown). Farmers had also invested in seed spreaders (21%) that were used ahead or behind the tractor and/or accomplished with some other field machine or even a quad bike. In addition, 11% of the farmers who had made investments had purchased a harrow with a sowing unit and 8% a new sowing machine with sowing facilities also for small seeds. Other machines/equipment with more than 10 mentions included weed harrows (5%), choppers (4%), direct drills (3%) and chaff spreaders (2%). The rest of the investments (5%) included: rollers, rollers with sowing units, mowers, cultivators, baling machines, steering assistance (GPS guidance), and subsoilers.

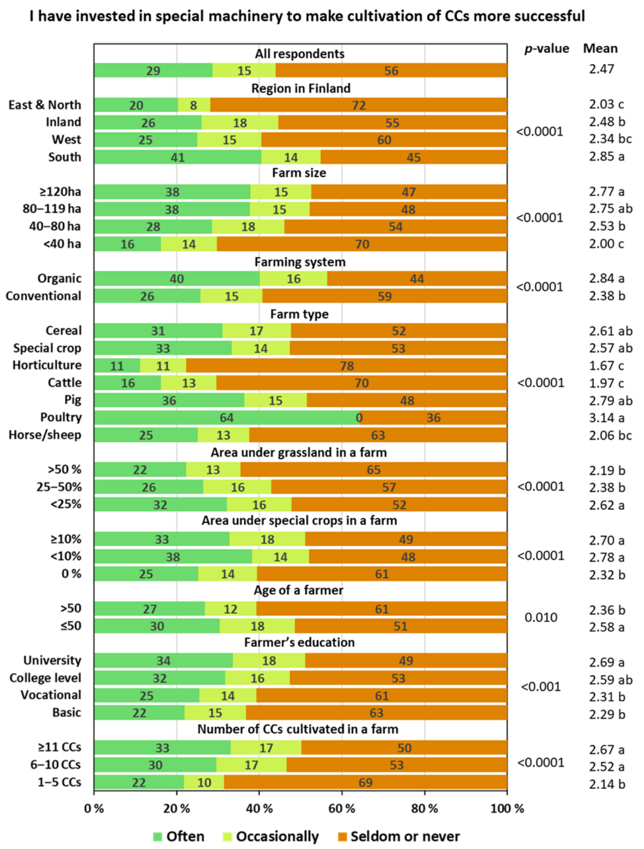

Figure 12. The distribution and means of farmers' answers to the statement: "I have invested in special machinery to make the cultivation of CCs more successful", (N = 1130) depending on farm and farmer characteristics (CCs, cover crops).

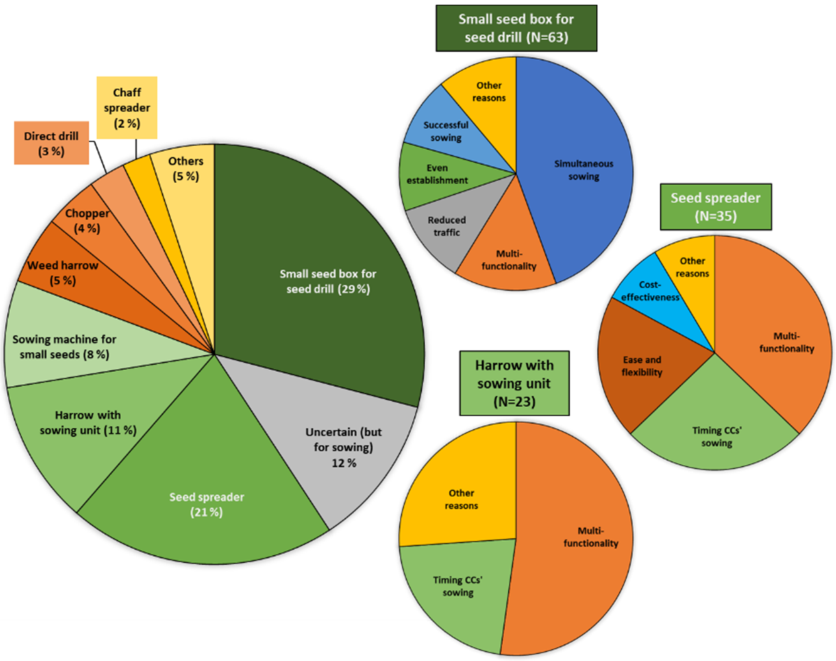

Figure 13. On the left, the share of machines and equipment (%) that farmers had invested in according to their free-word answers: 435 responses (corresponding to 39% of all respondents) with information on 461 investments. On the right, reasons given by farmers for the three most common investment.

4. Discussion

The cash crop is "the master" of a field parcel as it provides immediate income for the farmer, while CCs are more like "a farmhand" providing ecosystem services but requiring additional care and costs [20]. Many responding farmers considered CCs during the growing season (Figure 7). Many of them had also recognized or were at least aware [12] of the various ecosystem services provided by CCs [7,21]. On the other hand, the other end of the farmer community was represented by those who said that they considered CCs to be trivial as such, but "money talks", i.e., the subsidies encouraged the cultivation of CCs. This is understandable because a 100 € subsidy per hectare to support the cultivation of CCs is significant for Finnish farms, many of which are facing a profitability crisis [22]. The policy is indeed an important driver for the adoption of CCs in Europe, where the adoption intensity is in general low, though it ranges depending on the region [5]. Especially the requirements of the Nitrates Directive were found to encourage farmers to grow CCs in nitrate vulnerable zones [23]. Many non-adopters might become adopters in the case of stronger policy obligations or additional subsidies [5]. However, it is essential that the cultivation of CCs is not merely a "cosmetic" measure for a farmer just to acquire subsidies, but a cost-effective and target-oriented measure, and these call for farmers' commitment.

In 2021, when this farmer survey was carried out, the CC adoption intensity was 16% of Finnish farms. The respondents corresponded to 17.4% of all adopters, and they often took under-sown CCs into account during the growing season—and not only after harvest, when the land is completely at the CCs' disposal. This indicates some commitment to redeem expected benefits provided by the adoption of CCs for the production system per se [12], even though Kathage et al. [5] found that any agronomic motive was a much weaker driver for adoption of CCs than policies to encourage their use.

4.1. Farmers Acknowledged CCs in Sowing but Not in Fertilizer Use

Farmers sow CCs simultaneously or right after planting of the cash crop, and they took additional measures to enhance the establishment of CC under a cash crop. For example, the majority and especially those familiar with a high number of CCs, checked that the actual seeding rate corresponded to the planned density (Figures 7–11), while 8% of farmers never checked this, and 13% did so seldom. An adequate seed rate and careful establishment are prerequisites for the successful cultivation of CCs [24], but farmers may save costs by using low seed rates, which again may lead to sparse and uneven CC stands. Another measure to better ensure the success with cultivation of CCs was that as many as 44% of the respondents had made investments in machinery and equipment, from which 39% gave free-word specifications. Farmers with the propensity to invest were characterized as: educated, ≤50 years old, experienced with many CC species, having a large farm, a farm in South Finland, being an organic producer, and either having a poultry, pig, cereal, or special crop farm (Figure 12). Most frequently (≥29%) farmers had purchased an additional seed-box used for the drill of small CC seeds simultaneously with a cash crop (Figure 13). They argued this was to provide better conditions for CCs to germinate and emerge, and to reduce field traffic. The simultaneous drilling of CCs with a cash crop also partly explains why the most disagreed statement was that CC seeds should be sown after the cash crop but before seedling emergence (Figure 1). On the whole, equipment that facilitated the sowing of CC seeds was among the most popular investments, including seed spreaders for broadcast-planting (21% of invested farmers) which are used ahead or behind a tractor or a quad bike, harrows with a sowing unit (11%), and new sowing machines suitable for small seeds (8%). Drill- and broadcast-planting methods differ considering germination, plant stand establishment, growth, and biomass production of CCs [24,25], and thereby affecting the CCs' capacity to suppress weeds, scavenge nutrients, and control erosion [2,26–29]. Even though seed drilling provides better seed-to-soil contact and broadcast seeding may require higher seeding rate to compensate for the lower germination rate, success with either method is dependent on the CC-species and growing conditions [24]. In this study, farmers who invested in a seed spreader appreciated its multi-functionality and flexibility, e.g., the timing of CC sowing, as did farmers who invested in harrows with a sowing unit (Figure 13).

The majority (60%) of respondents agreed that the sowing time is critical for success with CCs (Figure 1). The respondents agreed with this statement more frequently in the case that the farm was very large and in South Finland (Figures 8 and 9). The time frame for optimal sowing is often limited in South-West Finland, where clay soils dominate, and the upper soil layer may dry fast due to low precipitation [30]. Hence, farmers with large field areas may face challenges with optimized sowing times especially for small-seeded CCs, while the seeds of the cash crops are usually larger and sown deeper. On the other hand, half of the farmers agreed that failure with CCs may as well be attributable to overly deep sowing (Figure 1). The challenge of sowing CCs was emphasized for broadcast-planting: farmers who specified their investments often highlighted that they used a seed spreader earlier but were dissatisfied with the uneven establishment of CCs and bought a sowing unit that enables the mulching of the small seeds (Figure 13). Organic producers were in general more concerned than conventional farmers about the criticality of the sowing time for success with CCs (Figure 6), which is most likely to be attributable to a higher dependency and the provision of ecosystem services [31]. It was agreed by 57% of respondents that the sowing time determines whether CCs compete with the cash crop (Figure 1). This may happen especially in the case of failures with cash crop sowing and establishment [32], e.g., due to harmful weather events [16], poorly germinating farm-saved seeds [33] or use of an aggressively growing CC-species like sweet clover [14].

The availability of seeds was not experienced as a problem (Figure 1) and most farmers neither produced farm-saved seeds for CCs (82%) nor purchased them from abroad (89%) (Figure 7). Experience with a high number (≥11) of CC species tended to increase the farmers' interest in importing seeds (Figure 11)—which is likely to be those with minor cultivation areas so far in Finland [14]. Moreover, 62% of farmers considered that seeds for unconventional CCs were expensive considering the risk of failure (Figure 1). Furthermore, 45% agreed—especially those with small or medium size farms (Figure 3)—that CC seeds are expensive compared to the benefits gained from their cultivation. Younger and/or more educated farmers tended to be less concerned about the price of CC seeds (Figures 2 and 4).

The majority of Finnish farmers adjusted their fertilizer use according to the cash crop only (46% always, 32% often) without considering the requirements of CCs or impacts of the CC on cash crop nutrition (Figure 7). Hence, CCs were not seen to compete for nutrients with a cash crop. In fact, CCs often reduce the reliance on N fertilizers in cropping systems [3,34]. Another farmer survey carried out in four EU-countries revealed that improved N use per se was hardly ever ($\leq$2.7%) the primary reason for adopting CCs [5], even though CCs reduced nitrate leaching by 69% globally [4]. In Finland, organic farmers acknowledged the contribution of CCs to fertilizer use more often than conventional producers (Figure 10), and especially in the case of large organic farms (p-value < 0.001, data not shown). The timing of the release of the temporal N storage of CCs determines how and when N is eventually used. Management practices and CC choices contribute to the effectiveness of CCs in optimizing soil N retention and supplying N for a cash crop [35].

4.2. Harvesting and Quality of a Cash Crop

Farmers considered the existence of the CCs when they harvested the cash crop. They mostly agreed (58%) that early cash crop harvesting ensured that the CCs did not hamper the harvest (Figure 1): more frequently in East/North Finland with short growing season and higher risks to the harvest than in South Finland (Figure 5). On the other hand, respondents did not strongly agree that CCs delayed harvesting (Figure 1). The statement most agreed with was that the respondents harvested the cash crop as soon as it matured and was harvestable (Figure 7)—and even more frequently on very large farms, which was likely to avoid risks of lodging and quality deterioration, as rains become more frequent later in the growing season [16]. In the cases that the farmers take the CCs into account in the timing of the harvest, it is likely that an early harvest was valued because it improves the CCs' capacity to produce abundant biomass and comprehensive soil cover during the autumn. According to experiments carried out in Sweden, the biomass production capacity of CCs after harvesting correlated with the abundance of CC plant stands before harvest [36]. To further support CC growth, 64% of farmers answered that they harvested their cash crops always or often with a high stubble height to avoid damaging the CCs, and 45% reported that they take measures to avoid cash crop residues suppressing the CCs (Figure 7). Hence, farmers seemed to strive for a win—win situation considering both the success of the cash crop and the CCs during the harvest, however, without investing much (in other machines than sowing units) to facilitate the growth and handling of CC stands later in the growing season (Figure 13). Only some mentions of equipment investments were given in the free-word section of the questionnaire including weed harrows (5%), chopper (4%), chaff spreaders (2%), and even less frequently mowers and baling machines.

The farmers' views were mixed on the statement that CCs have no impacts on the quality of the cash crops: 38% of respondents agreed and 31% disagreed (Figure 1). In some studies CCs have improved quality of a cash crop [37]. Sixty-nine per cent of the respondents agreed that CCs have impacts on quality only if they grow above the cash crop: farmers in East/North Finland with short time frame for harvest agreed more frequently than those in South Finland (Figure 5), as did older and less educated farmers when compared to younger and university educated farmers (Figures 2 and 4). Abundant green biomass including weeds, green tillers, and CCs among the cash crop may keep the stand moist, expose grains and seeds to sprouting and fungal growth, as well as delay the harvest and make it difficult [38]. Quality may be at risk in such cases especially because rains are common during the late growing season in Finland [39].

5. Conclusions

A survey of farmers carried out in Finland indicated that farmers often took undersown CCs into account during the growing season. Sowing was especially considered critical for success with CCs, and therefore, the majority of respondent (56%) always checked the CCs' seeding rate before sowing. Furthermore, when farmers made investments, they prioritized machines that facilitate sowing. The availability of commercial seeds was not a problem, and most farmers neither produced farm-saved seed of CCs (82%) nor purchased them from abroad (89%). Farmers adjusted the fertilizer rate according to the cash crop: only 10% considered the CCs' needs as well. Early harvesting of a cash crop was considered important by 58% of farmers to ensure that the CCs did not hamper the harvest. Farmers harvested cash crops as soon as they matured and were harvestable. The farmers' views were mixed as to whether CCs had an impact on the quality of a cash crop or not. The finding that Finnish farmers often took under-sown CCs into account during the growing season implies the farmers' aims to reap potential benefits from CCs. Agricultural policy is a focal tool to support the shift towards the adoption of CCs in Europe. It is, however, important that it is a cost-effective and target-oriented policy measure. It was recognized that those farmers who were inclined to make an investment to support the cultivation of CCs were often educated, ≤50 years old, had experience with many CC species, had a large farm (as often in South Finland), were organic producers, and had poultry, pig, cereal, or special crop farms. Subsidized farmers who also make investments are likely to aspire reaping the ecosystem services, especially improved soil health provided by CCs. Hence, their experiences are of core importance when sharing knowledge between farmers to encourage the implementation of CCs on a larger scale. It is, however, essential that knowledge gaps are filled with tailored experiments and extension services have access to the latest know-how to support farmers during the transition phase towards extensive use of CCs.

Supplementary Materials: The following supporting information can be downloaded at: https://www.mdpi.com/article/10.3390/agronomy13020499/s1. Figure S1: The distribution of farmers' answers (N = 1130) depending on the farm type (RMSD, row mean scores difference; CCs, cover crops). The share of each answer choice (%) is shown within each bar except unless it was <3%. Means with the same letter do not differ significantly from each other (at $p \leq 0.05$). Figure S2: The distribution of farmers' answers (N = 1130) depending on the share of the area under different crop types on the farm (NZC, nonzero correlation; CCs, cover crops). The share of each answer choice (%) is shown within each bar. Means with the same letter do not differ significantly from each other (at $p \leq 0.05$). Figure S3: The distribution of farmers' answers (N = 1130) depending on the share of cereal area on the farm (NZC, nonzero correlation; CCs, cover crops). The share of each answer choice (%) is shown within each bar unless it was <3%. Means with the same letter do not differ significantly from each other (at $p \leq 0.05$). Figure S4: The distribution of farmers' answers (N = 1130) depending on the share of special crop area on the farm (NZC, nonzero correlation; CCs, cover crops). The share of each answer choice (%) is shown within each bar unless it was <3%. Means with the same letter do not differ significantly from each other (at $p \leq 0.05$). Figure S5: The distribution of farmers' answers (N = 1130) depending on the share of other crop areas on the farm (NZC, nonzero correlation; CCs, cover crops). The share of each answer choice (%) is shown within each bar unless it was <3%. Means with the same letter do not differ significantly from each other (at $p \leq 0.05$). Figure S6: The distribution of farmers' answers (N = 1130) depending on their age (NZC, nonzero correlation; CCs, cover crops). The share of each answer choice (%) is shown within each bar unless it was <3%. Figure S7: The distribution of farmers' answers (N = 1130) depending on the farmer's education (NZC, nonzero correlation; CCs, cover crops). The share of each answer choice (%) is shown within each bar unless it was <3%. Means with the same letter do not differ significantly from each other (at $p \leq 0.05$). Figure S8: The distribution of farmers' answers (N = 1130) depending on the farm type (RMSD, row mean scores difference; CCs, cover crops). The share of each answer choice (%) is shown within each bar unless it was <3%. Means with the same letter do not differ significantly from each other (at $p \leq 0.05$). Figure S9: Bubble charts indicating how the answers on the farmers' views on statements concerning sowing-related issues (x-axis) were distributed when compared to the farmers actions (y-axis) when stated as: "Before sowing I check the sowing density of cover crops (CCs)". Figure S10: The distribution of farmers' answers (N = 1130) depending on the share of grassland area on the farm (NZC, nonzero correlation; CCs, cover crops). The share of each answer choice (%) is shown within each bar unless it was <3%. Means with the same letter do not differ significantly from each other (at $p \leq 0.05$).

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