
AGRI LOGIC
MANAGEMENT, CONSULTANCY AND RESEARCH

FARMER FIELD BOOK ANALYSIS

ISLA Programme Vietnam 2016/17 to 2018/19

Table of contents

Introduction

- The companies Acom, Louis Dreyfus Commodities, Olam Vietnam Ltd and Simexco are partners in the ISLA landscape programme in Vietnam. With co-funding from ISLA, JDE Coffee and Lavazza, these companies implement landscape level projects in parts of their respective coffee supply chains. A component in each of these projects is the implementation of the Farmer Field Book (FFB). In the context the ISLA programme the FFB implementation serves multiple purposes:
  - Provide detailed multi-crop performance data to participating farmers and farmer groups;
  - Assist companies to obtain better insight into the performance of their suppliers; and
  - Provide insight into the degree to which the ISLA programme is meeting its objectives.
- Across 2 provinces 900 farmers kept daily records of their farming activities, investments and returns as well as their production assets and their tree stocks during the 2016/17 season. In the next seasons, Simexco and LDC opted to work with their own data management systems. In the 2017/18 and 2018/19 coffee seasons, 150 farmers in the Lam Dong supply chain of Acom and 150 farmers in the Dak Lak supply chain of Olam used the FFB.
- With the FFB programme we generate 4 types of reports, of which the first 3 are not publicly available:
  1. Individual Farm Management Reports: Detailed performance reports on a per farm and per ha basis for each farmer in the programme;
  2. Farmer Group Reports: Detailed reports at farmer group level, which allow farmers to compare their own performance to that of their peers;
  3. Company Reports: Reports for each company, containing more in-depth statistical analysis on supply chain level; and
  4. ISLA Programme Report: Overall report combining FFB data from different companies with in-depth programme level analysis.
- In this report, the ISLA Programme Report, we present the analysis of 3 years of FFB data of farmers in the Acom and Olam supply chains. Results from earlier publications where Simexco and LDC were included therefore differ from what is presented here.
- We include a deep-dive into the current and historical situation around the use of glyphosate-based herbicides as this is a topic of much interest in the global and Vietnam coffee sectors. For historical data we rely on FFB records from 2005 to 2010 that were made available to us by JDE.

Readers' guide

- To facilitate time-pressed readers, we start of with the **Conclusions** in the first section. Subsequent sections contain the background analyses on which the conclusions are based.
- The section **Household and Farm Profiles** outlines a charactersation of the FFB farmers and their farming system. It also includes a classification of farms across **Agro-Forestry Classes** which is used in some of the subsequent analyses.
- The **Farm Management** section deals with labor use, payment of workers, the gender wage gap, nutrient management, irrigation, the use of biocides and specifically of products banned by sustainability standards and national law, and replanting of coffee.
- In the **Production** section we dive deeper into production and productivity figures, where deemed useful we split these by province and Agro-Forestry Class. We identify drivers for productivity.
- **Farm Economics** shows cost of production, revenue and profit margins, including Benefit Cost Ratios (BCR) and Return on Assets (RoA) ratios for farmers. Farm management variables that drive the RoA are identified.
- In the **Environmental Performance** section we discuss the Environmental Impact Quotient and coffee related carbon emissions. A sub-section of this deals with **glyphosate use** which is currently of much interest to several coffee roasters and exporters. Here we include some historical FFB data to put current glyphosate use into perspective. We also include a more in-depth analysis of different weed control strategies and how these have changed over time.
- **Recommendations** are provided in the final section.

Conclusions

Conclusions: We observe positive change on most aspects, except those that are directly influenced by the coffee price.

	2016/17	2017/18	2018/19	Change	Description and units
	**2.73**	**2.98**	**2.53**		Benefit Cost Ratio
	10.9%	**7.4%**	**8.8%**		Return on Assets
	**410**	**252**	**227**		Irrigation water (m^3/Mt coffee)
	**1.28**	**1.10**	**1.16**		Emissions (Mt CO_2e/Mt coffee)
	**5.5**	**1.5**	**0.5**		EIQ #/Mt coffee
	**15.3%**	**1.2%**	**0.5%**		Use of banned pesticides (% of farmers)
	**8.4%**	**3.5%**	**3.3%**		Gender wage gap

Conclusions

- **Household and farm profiles:**
  - FFB records are kept by 300 farmers in 8 communes of 3 districts in Lam Dong and Dak Lak province. The sample is not representative for the coffee sector in these provinces.
  - Most farmers are male (87% and 88% in Dak Lak and Lam Dong); the share of ethnic minority farmers is relatively high in Lam Dong at 35% and 39% for males and females respectively.
  - 64% of farmers fall in the 45 to 59 years age bracket, while 23% is over 59, this may affect future supply availability
  - Diversification with non-coffee trees is increasing on roughly half of the farms in Dak Lak. In Lam Dong mono-cropping persists. The share of farmers with Highly diversifed farms in Dak Lak increased from 65% to 69%.
  - We identify 3 Agro-Forestry Classes. Farmers with more than 30% of non-coffee trees are labelled as Highly diversified, between 15% and 30% non coffee trees are Medium diversified and farmers with less than 15% non-coffee trees are considered Monocrop coffee farmers.
  - Increased diversification correlates with lower coffee tree stocks, but coffee planting densities remain stable. Durian and avocado tree stocks show the strongest growth, but start from a low base value.

- **Labor use:**
  - Labour use efficiency has improved and farmers appear to try and reduce costs for hired labour. On a per farm basis, the use of male hired labour dropped by 38% and that of males in the household by 22%.
  - Weeding, pruning and harvesting make up 77% of total labour use in 2018. The weighted average daily rates of hired labour increased by 4.4% in 2017 and by 8.3% in 2018, more than double the rate of inflation over the same period of time.
  - Optimisation of labour use is found on 64% of the farms. Changes are largest at the smallest and largest farms, but probably for different reasons.
  - On average male workers earn slightly more per day. The gender wage gap has decreased. The gender wage gap is often higher on female-owned farms than on male-owned farms.

Conclusions

- **Farm management:**
  - The share of farmers who spray biocides has reduced significantly and is down to less than 10% in Dak Lak. Average working hours used for this activity are minimal and dropped significantly as well.
  - Irrigation volume per tree was reduced significantly, but 2016 was an exceptionally dry year. Changes from 2017 to 2018 are minimal, except for Monocrop and Medium diversified farms in Lam Dong.
  - In the Lam Dong FFB areas, irrigation is an incidental activity driven by seasonal weather patterns, while in Dak Lak nearly all farmers need to irrigate every year.
  - Modelling of irrigation water use per ha shows that farmers are cost-sensitive, those with higher costs per m^3 water tend to use less of it.
  - Inter-communal differences in irrigation water use can be significant, but in most places farmers appear to be converging on what are perceived to be more optimal levels of water use.
  - Nitrogen use efficiency has improved in 2 consecutive years, and is getting closer to what we think is optimal, but room for improvement remains. Extreme outliers have reduced in frequency of occurrence and level of over-application.
  - Phosphorus over-application has gone down steadily, while potassium has increased relative to N and P, but the potassium balance remains negative on average as yields have increased.
  - Rates of rejuvenation have declined in Dak Lak but are increasing in Lam Dong. Coffee tree stocks are either stable or growing in both provinces.
  - The use of hazardous and banned biocides has gone down significantly. No biocides banned by national regulations are used.
  - The issue with using biocides banned by standards pertained to 20 products and 14 active ingredients in 2016, but is now down to a single product called Hinosan.

Conclusions

- **Production:**
  - Average productivity is 3.95 Mt green bean per ha in Lam Dong and 2.55 Mt/ha in Dak Lak. We find no correlation between farm size and productivity across the whole group, but a correlation is present in Lam Dong.
  - We find no significant differences in yields between the 3 agro-forestry classes, except in Lam Dong where diversified farms show lower yields in 2017 and 2018.
  - We model yield and present groups of variables for location, socio-economic conditions and farm management and their effect sizes.
  - Location effects are significant in all years for communes in Lam Dong province.
  - Farming households of whom the male belongs to the Kinh majority group show consistently higher yields. In 2018, the effects of education become significant and large.
  - Pruning and K applications remain the limiting management aspects where most farmers can make the largest improvements.

- **Farm economics:**
  - Prices affect margins, but optimisation of investment has offset the coffee price decline to some extent.
  - Cost reduction was strongest in Lam Dong, consequently, margin drop there was less severe than in Dak Lak and was observed only in 2017.
  - Production cost optimisation improved through 16% lower fertiliser investment and 17% lower hired labour cost in Lam Dong. Dak Lak farmers reduced biocides and energy cost.
  - Profit margins per ha dropped even stronger than the per Mt values, farmers in Dak Lak earned 32% less in 2018 compared to 2016.
  - As a result, the Benefit-Cost Ratio (BCR) is stable (ish) in Lam Dong, whereas farmers in Dak Lak show a worsening situation with 70% of farmers earning less than 2 VND on every 1 VND invested.

Conclusions

- **Farm economics:**
  - The average rate of return on assets is down from 10.9% to 8.2%. Farmers with poor returns (<8%) used to produce just 16% of the total supply but they now make up for 37% of the total supply.
  - The share of farmers below the poverty line has increased by 5 points from 11% in 2016 to 16% in 2018.

- **Environmental performance, biocides and glyphosate:**
  - The environmental impact quotient per ha has dropped significantly from 17.5 to 1.2, indicating sharply reduced use of the most hazardous biocides.
  - Toxic loading, as measured by the EIQ rating, has reduced significantly, down to a level where we believe it is no longer a concern.
  - Lower EIQs do not say much about the use of specific chemicals that may, rightly or wrongly, receive much attention such as glyphosate.
  - Glyphosate use may be on a downward trend and appears increasingly concentrated among a few heavy users, as witnessed by the increasing standard deviation of average use.
  - Glyphosate use tends to peak in July/August, with a final round of application in October to clean the field before the harvest begins.
  - We estimate that the coffee sector uses between 5,800 and 13,300 liters of glyphosate per year. Reportedly, Vietnam imported 30,000 Mt of glyphosate in 2018, half of which is used in agriculture.
  - Brush cutters are increasingly being used to control weeds and provide a viable, non-chemical alternative to glyphosate and herbicides in general.

Conclusions

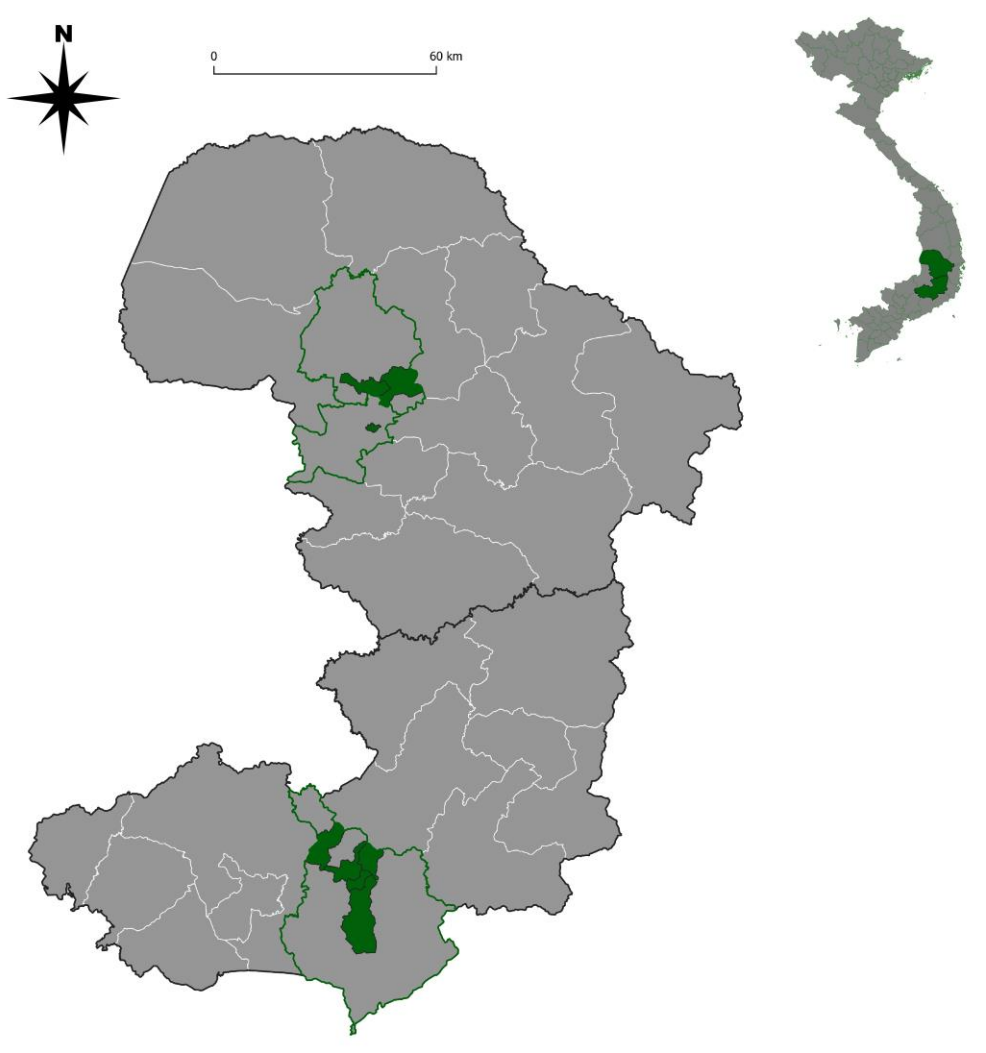
- **Environmental performance, carbon footprint:**
  - Coffee can be a mitigating factor in climate change, removing more carbon from the air through biomass growth than it emits in production. Fertiliser and diversification are key factors in this. The role of fertiliser management is probably the most critical factor in optimising the carbon footprint.
  - In 2017 Highly Diversified farms had a significant negative carbon footprint per ha, but a shift in fertiliser management has pushed their average back into the group of carbon emitters.
  - The farmers with a negative carbon footprint are also those who use nitrogen most sparingly. Their yields are not significantly different from those with higher footprints while their margins are better.

Results
Household and Farm Profiles

Household profiles: FFB records are kept by 300 farmers in 8 communes of 3 districts in Lam Dong and Dak Lak province

Province	District	Commune	Nr of FFB farmers	Share of total
Dak Lak	Cu M'gar	Ea Drong	66	22%
		Ea Pok	50	17%
	TP Buon Ma Thuot	Tan Hoa	50	17%
Lam Dong	Di Linh	Gung Re	10	3%
		Tan Chau	50	17%
		Tan Lam	74	25%
		Tan Nghia	10	3%
		TT Di Linh	6	2%
Total			**300**	**100%**

- The sample size is limited to a relatively small number of communes. While the samples are representative for the projects in which these farmers participate, they can not be considered representative for both provinces as a whole.
- In the remainder of this report, we will on occasion analyse data by province. The farming systems and performance of farmers vary significantly between the two.

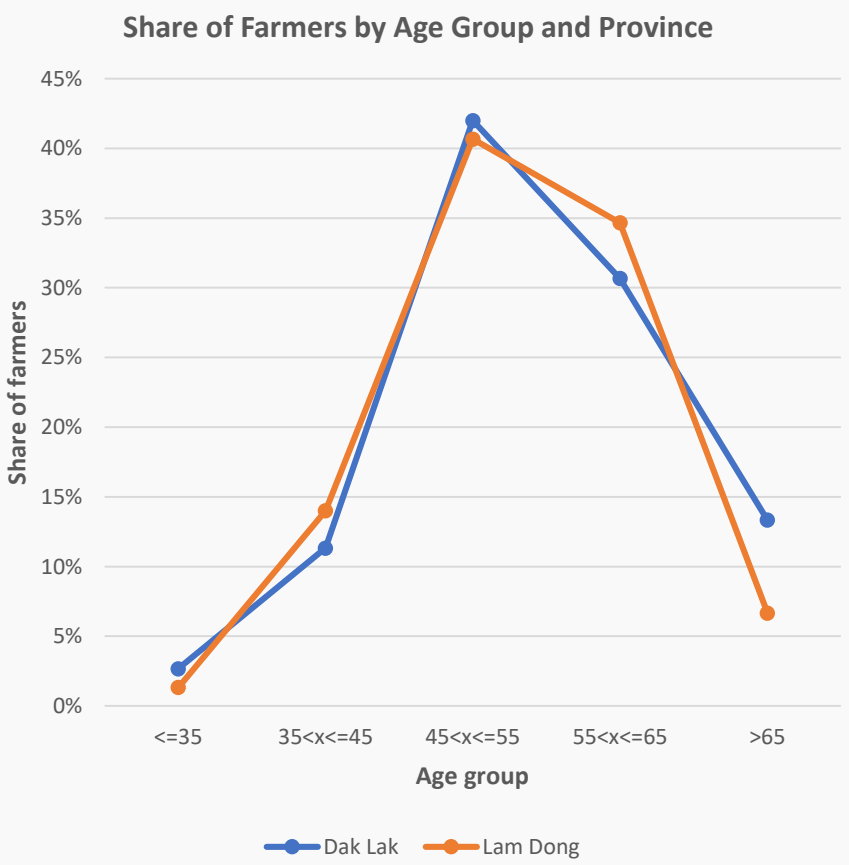


Household profiles: Most farmers are male, the share of ethnic minority farmers is relatively high in Lam Dong

Aspect	Units	Dak Lak	Lam Dong
Gender	% male	87%	88%
Year of birth	Year	1964	1965
First year of growing coffee	Year	1995	1994
Ethnicity (male)	% kinh	100%	65%
Ethnicity (female)	% kinh	100%	61%
No. of female children in household (<16 years old)	#	0.24	0.51
No. of male children in household (<16 years old)	#	0.27	0.47
No. of people dependent on farm for their living	#	4.1	4.4
Land ownership	% red book	85%	99%
Education level (male)	% primary or higher	67%	75%
Education level (female)	% primary or higher	72%	74%
Decision-making	% with joint decision making	95%	57%
Participating in projects since	Year	2013	2013

- FFB farmers are predominately males in their early fifties who have been growing coffee since the mid-nineties.
- The majority of male and females in the households are of the Kinh ehtnic majority.
- We find a weak (R^2=0.21) postive correlation between belonging to the Kinh ethnic group and practicing joint-decision making with regards to farm management.
- Average age does not differ significantly between the provinces.
- The number of people dependent on the farm for their living is 4.1 to 4.4 persons on average.
- Nearly all farmers have de-facto ownership of their land via the so-called red book. There is some renting of land observed among 15% of the farmers in Dak Lak.
- On average FFB farmers have engaged with a coffee project since 2013.

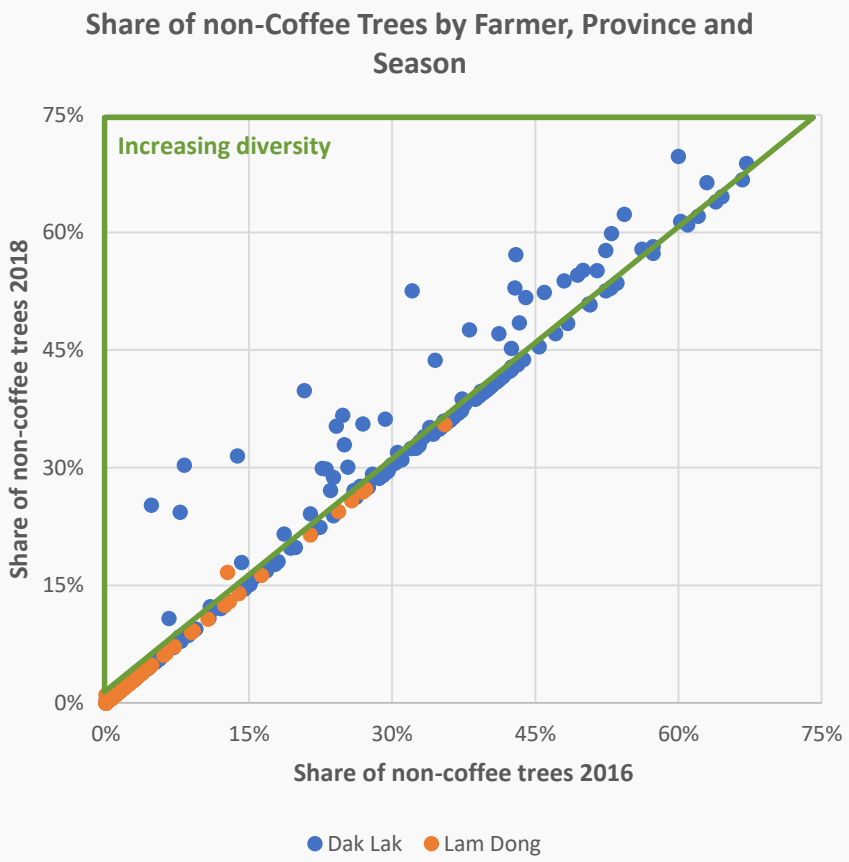
Household profiles: 64% of farmers fall in the 45 to 59 years age bracket, while 23% is over 59, this may affect future supply availability



- Around 40% of farmers fall in the 46 to 55 years age group, while less than 5% of the sample is younger than 35 years. This makes the coffee sector very different from the total VN workforce, where 45% are younger than 35 years[1].
- Among the Dak Lak-based farmers we see an average age of 55, versus 54 in Lam Dong. In many coffee producing countries, the age of coffee farmers is similarly high or higher still. In Colombia the average coffee farmers' age is 56 years[2] and across Africa it is over 60 years[3].
- We should bear in mind that farmers are generally older than the average age of the workforce, not only because farming is not seen as an attractive proposition for young people, but also because the required investment in land and equipment can be a barrier to entry for those younger people that do wish to farm.
- Farmers being self-employed entrepreneurs tend to work beyond the age of 65, 17% of the FFB farmers are over 59 years old and 11% is over the age of 65.
- By comparison, the share of farmers over 65 in the EU was 31% in 2017[4].
- Looking 5 to 10 years ahead it is certainly wise to monitor the share of farmers across the age groups and perhaps it is already useful to stimulate younger farmers to enter the sector to avoid being caught out by the bulk of farmers that will retire at some point.

Farm profiles: Farmers in Dak Lak are increasingly diversifying, but not (yet?) to the detrimment of coffee production

- Average farm sizes and tree stocks differ significantly between farms, with the larger farms in Lam Dong.
- Comparing the share of non-coffee trees on farms in Lam Dong and Dak Lak from 2016 to 2018 shows that diversification continues unabated in Dak Lak. Nearly half of the farms have a greater share of non-coffee trees in 2018 than they had in 2016.
- In Lam Dong this is far less prevalent, with just a few farmers moving in this direction. We should note that the sample in Lam Dong is probably biased towards “Pure-play coffee farmers” in areas with larger than average coffee farms.
- We typically see that diversification is often driven by economic necessity, i.e. reaping an income from limited land. When land is more abundant, it is probably more economical to focus on single crop and do that really well.
- We suspect that in other areas in Lam Dong where either land holdings are smaller and/or growing conditions less optimal for coffee, we would find a greater level of diversification.



Farm profiles: Diversification with non-coffee trees is increasing on roughly half of the farms in Dak Lak. In Lam Dong mono-cropping persists. The share of farmers with Highly diversifed farms in Dak Lak increased from 65% to 69%.

- Our Agro-Forestry classification is based on the share of non-coffee trees on a farm. Farmers with less than 15% of non-coffee trees fall under the “Mono-crop coffee class”, farmers with 15% to 30% non-coffee trees are considered “Medium diversified”, farmers with more than 30% non-coffee trees are considered “Highly diversified”. Nearly al the Highly diversified farms are found in Dak Lak, while most of the Monocrop farms are in Lam Dong (Fig 2).
- In Dak Lak we see a shift over time with 47% of farmers having increased their share of non-coffee trees on the farm by an average of 5 percentage points. In Lam Dong such change was rare, with just 2% of farmers making this move (Fig 2).

Fig. 1 Change in Share of Non-Coffee Trees from 2016 to 2018 by Province

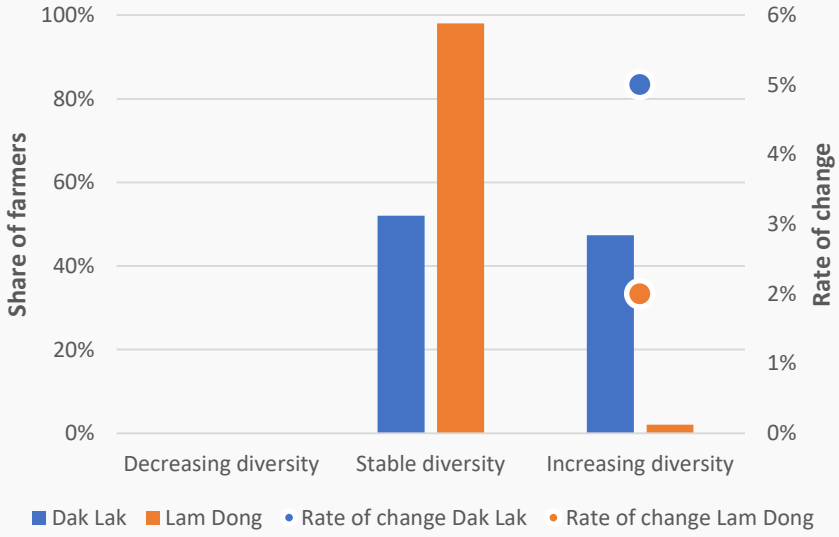
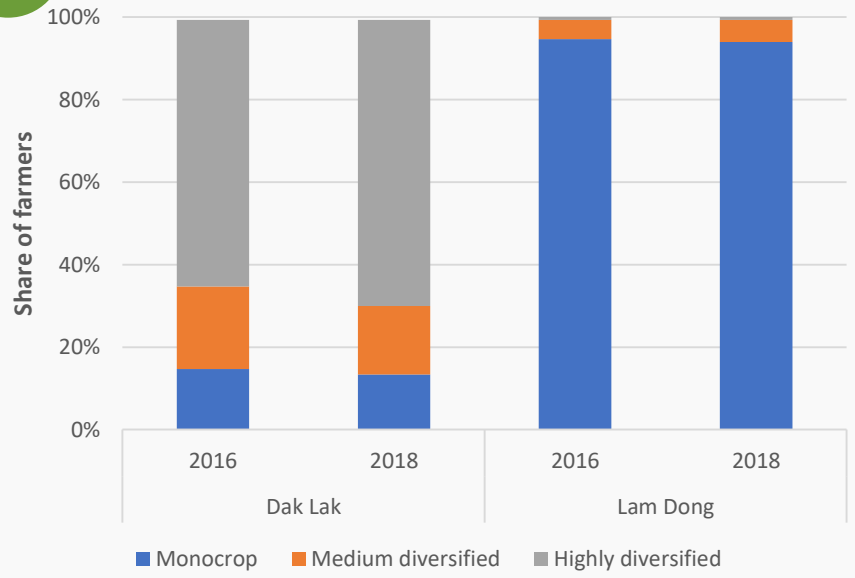
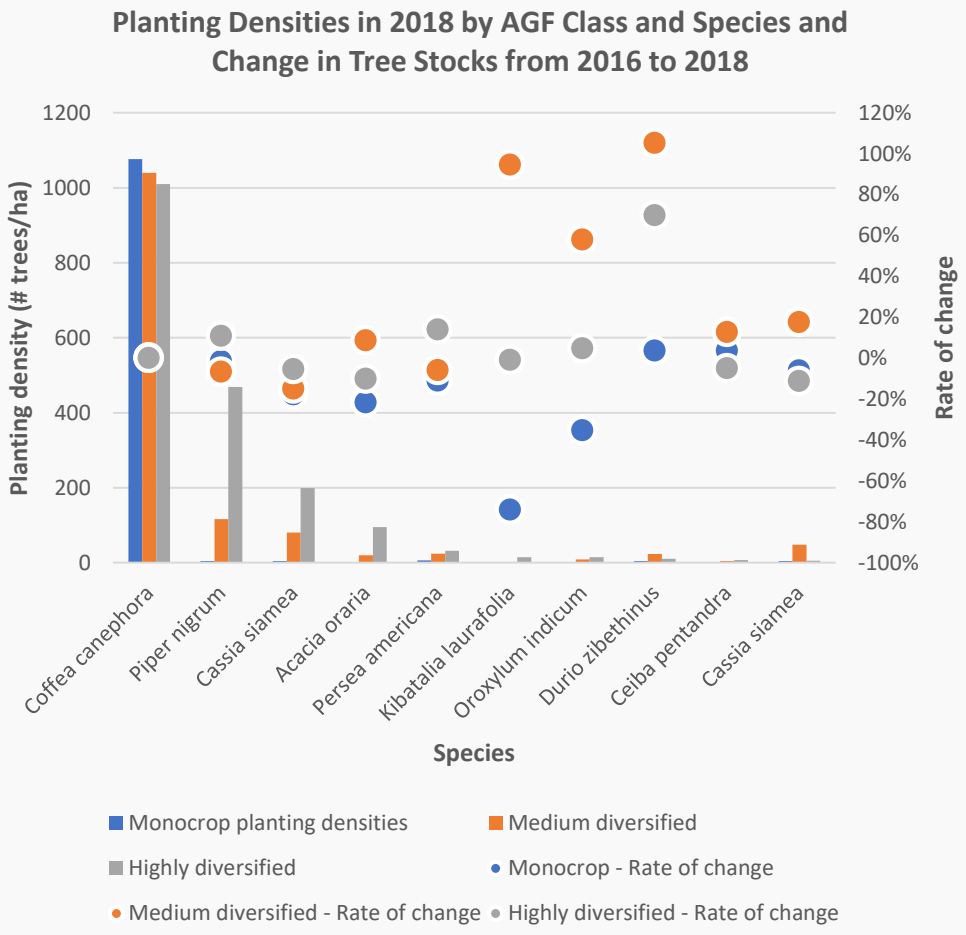


Fig. 2 Share of Farmers by AGF Class, Season and Province



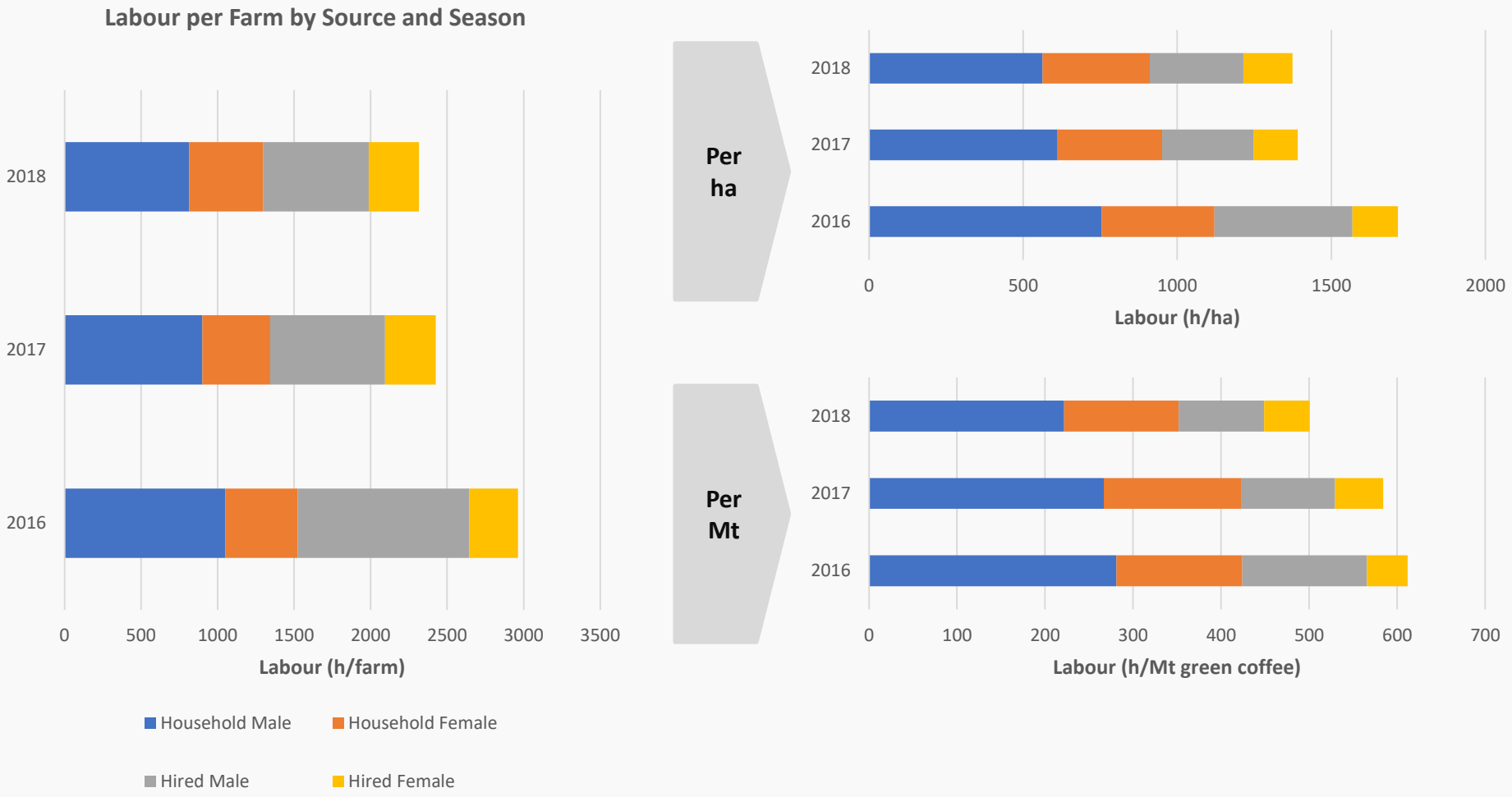
Farm profiles: Increased diversification correlates with lower coffee tree stocks, but coffee planting densities remain stable. Durian and avocado tree stocks show the strongest growth, but start from a low base value.

- Coffee tree stocks have been stable from 2016 to 2018 and range from 1,009 trees/ha for Highly diversified farms to a maximum of 1,075 on Monocrop farms.
- Contrary to 2016, the differences in planting densities for coffee are now statistically significant between all 3 AGF classes.
- The largest rates of change in tree stocks are found for *Durio zibethinus, Kibatalia laurafolia and Oroxylum indicum.* Especially among the Medium diversified farms do we find high rates of change. Tree stocks are more stable among the Highly diversified farms, with the exception of *Durio zibethinus,* which increased by 70% and *Persea amecana* which jumped by 14%.
- Still, coffee remains the mainstay of most farmers, followed by pepper (*Piper nigrum*) on Highly diversified and Medium diversified farms.

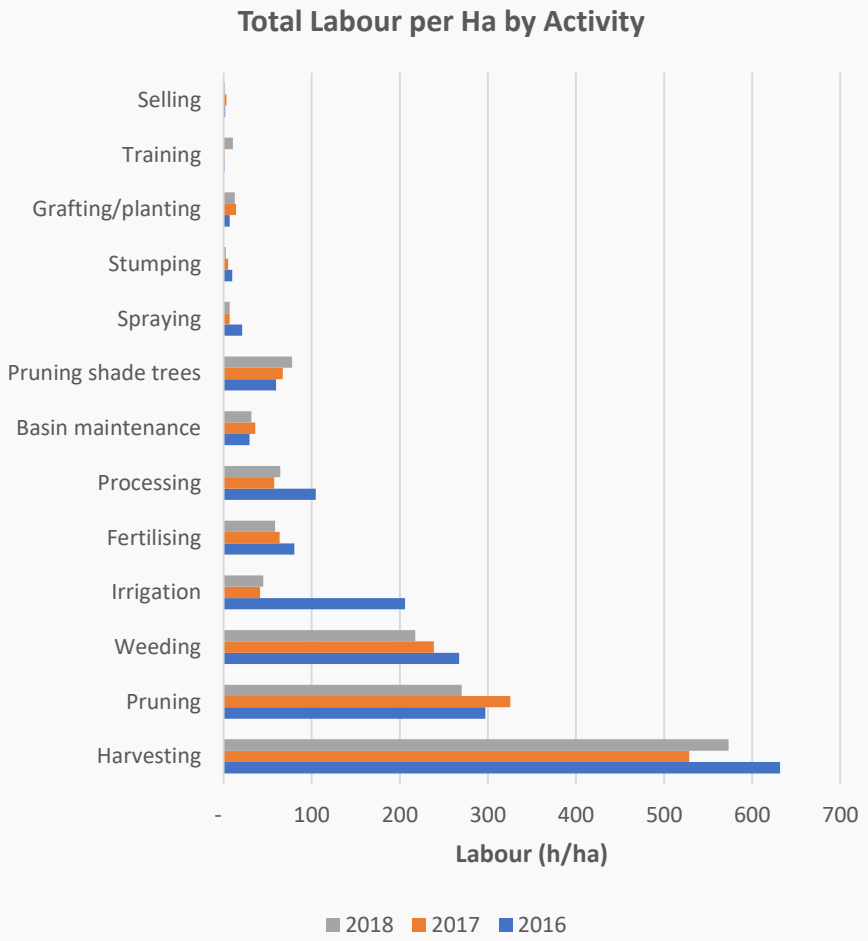


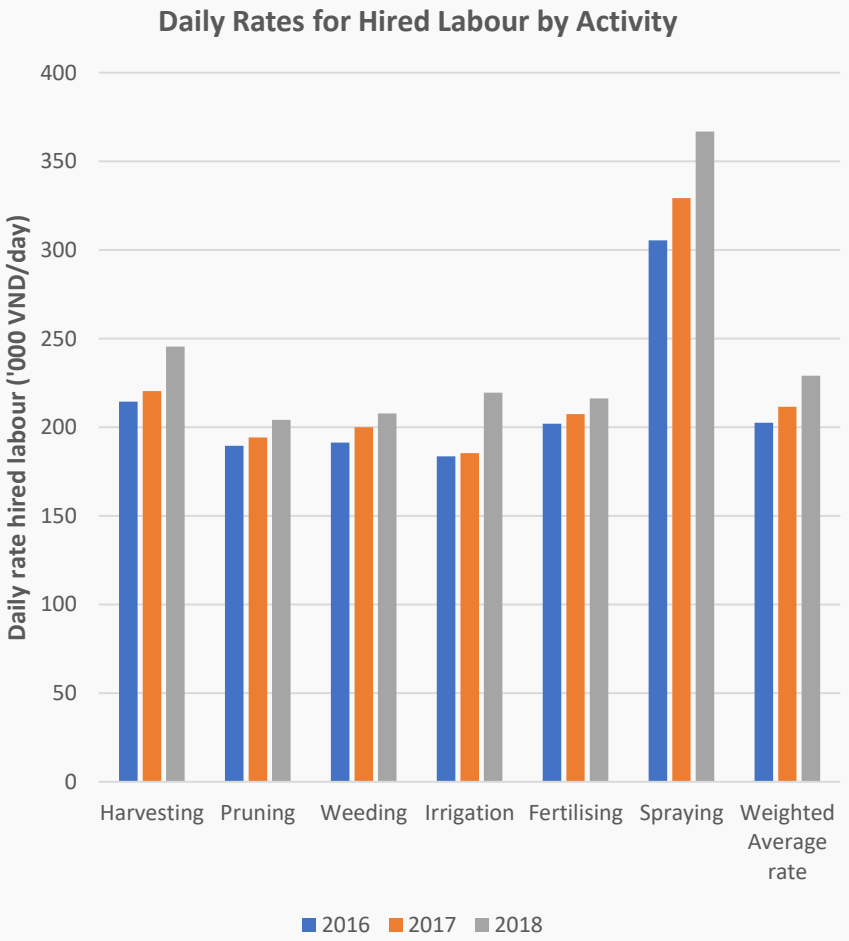
Results
Farm Management

Farm management: Labor use efficiency has improved and farmers appear to try and reduce costs for hired labour. On a per farm basis, the use of male hired labour dropped by 38% and that of males in the household by 22%.



Farm management: Weeding, pruning and harvesting make up 77% of total labor use in 2018. The weighted average daily rates of hired labour increased by 4.4% in 2017 and by 8.3% in 2018, more than double the rate of inflation[5]





Farm management: Optimisation of labour use is found on 64% of the farms. Changes are largest at the smallest and largest farms, but probably for different reasons

- The majority of farmers show an increasing labour use efficiency (Fig 1). The changes are most pronounced at the extremes in terms of farm size, with the middle sections who run farms ranging from 1.8ha to 3.6ha showing the lowest amount of change (Fig 2).
- At the far right, on the largest farms, reliance on hired labour is greatest, and likely the combination of low coffee prices and rising labour costs is driving economising on this cost item. On the smallest farms, where use of household labour is more prevalent, we suspect the reduction is more driven by farmers working outside their farms.

Fig. 1

Change in Labour Use per Mt from 2016 to 2018 by Farmer

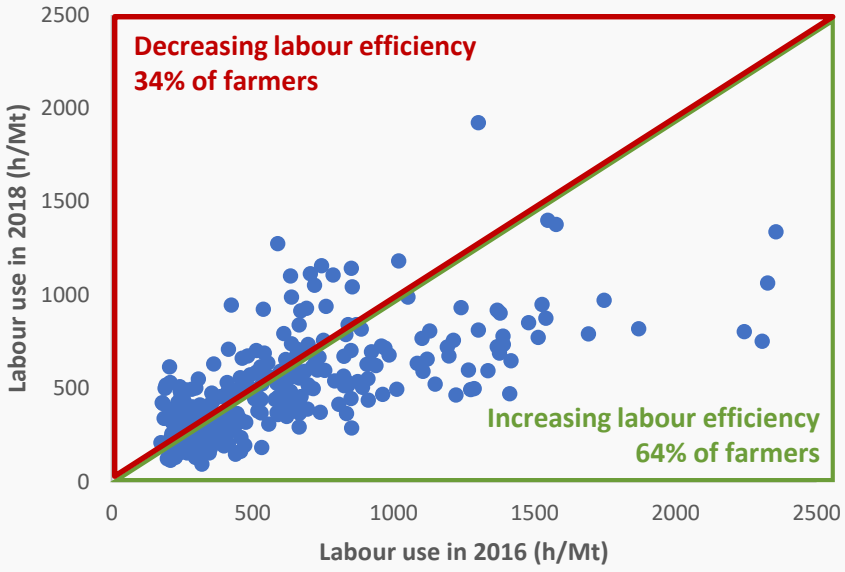
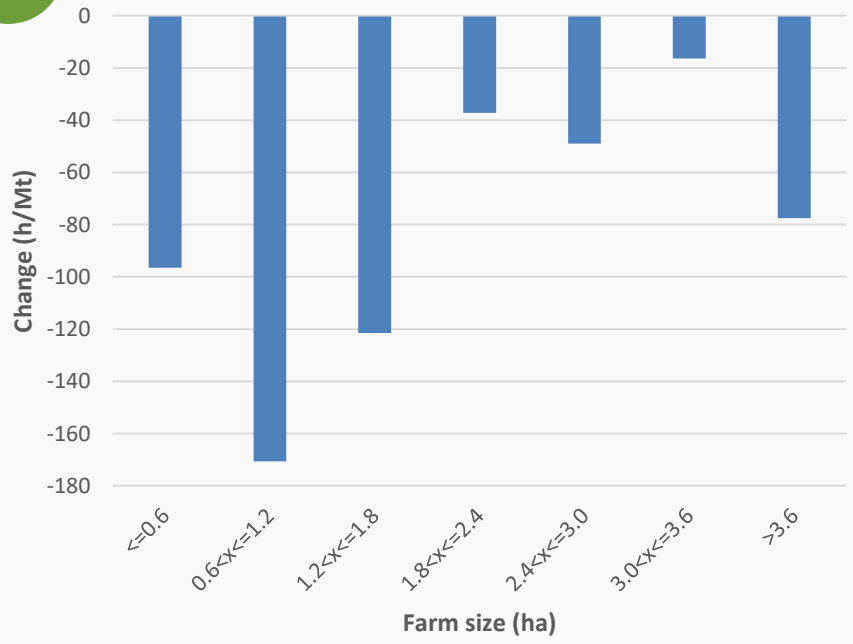


Fig. 2

Change in Labour Use per Mt Coffee by Farm Size



Farm management: On average male workers earn slightly more per day. The gender wage gap has gone down, but is often higher on female-owned farms.

- Average daily rates for male hired labour explain most of the 8% increase in the weighted average daily rate increase we observed from 2017 to 2018 (Fig 1).
- Average daily rates of female workers have barely moved during the last 2 seasons, yet the gender wage gap has gone down (Fig 1&2).
- The gender wage gap is calculated by subtracting the median rate for women from the median rate of men and dividing this by the median rate for men. Back in 2016 this reached 8.4% and has now dropped to 3.3%. A significant improvement, though still more than double the lowest level that we observe in 2017 when it reached 1.4%.
- It appears to matter what the gender of the farm owner is. On male-owned farms we see a consistent downward trend on the gender pay gap, while in 2 out of 3 years, female-owned farms show greater gender pay gaps (Fig 3).

Fig. 1 Change in Daily Rate on Previous Season by Gender

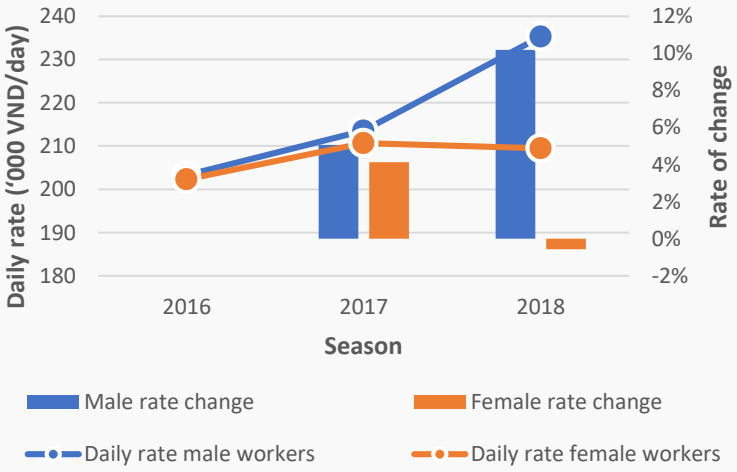


Fig. 2 Gender Wage Gap

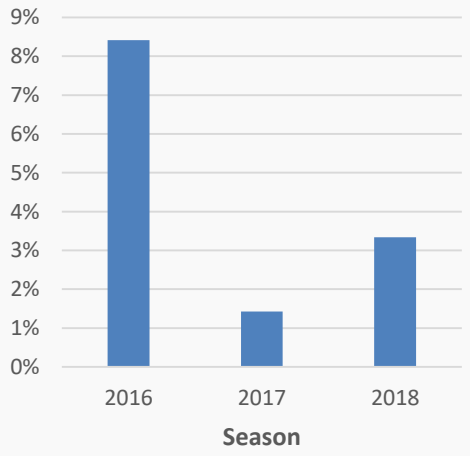
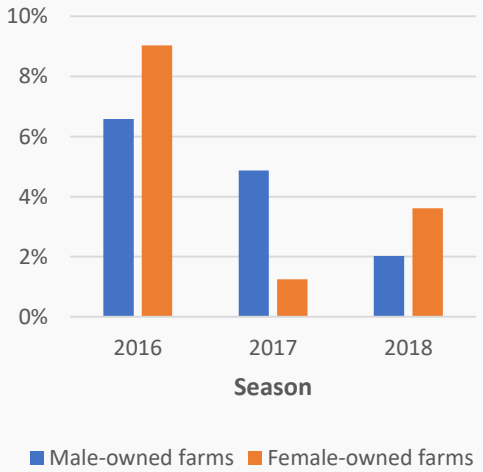
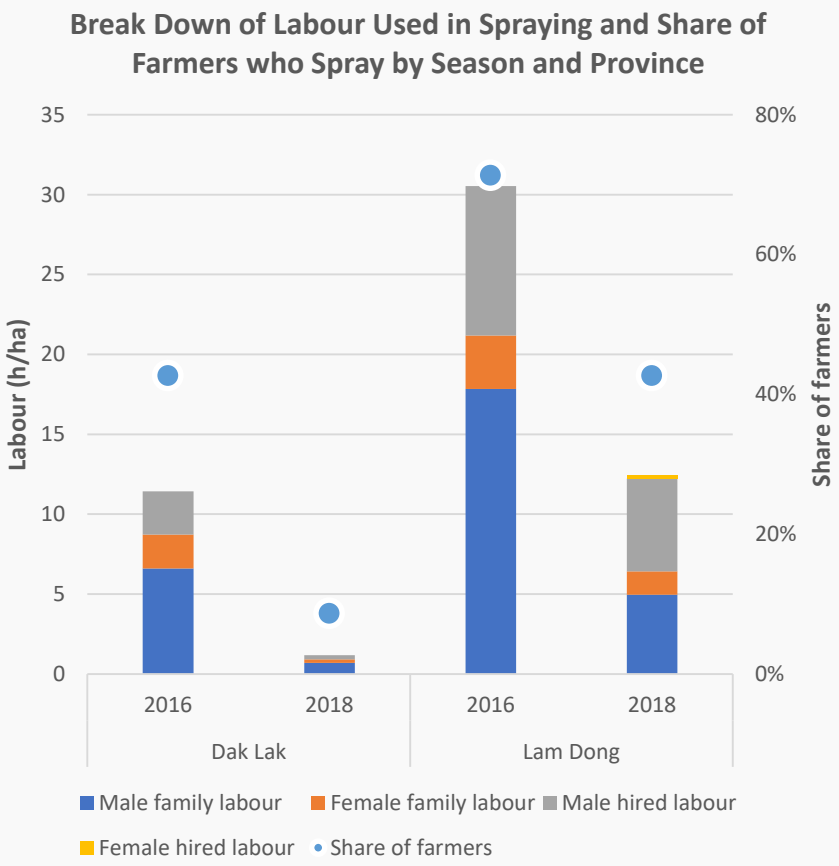


Fig. 3 Gender Wage Gap by Gender Farm Owner

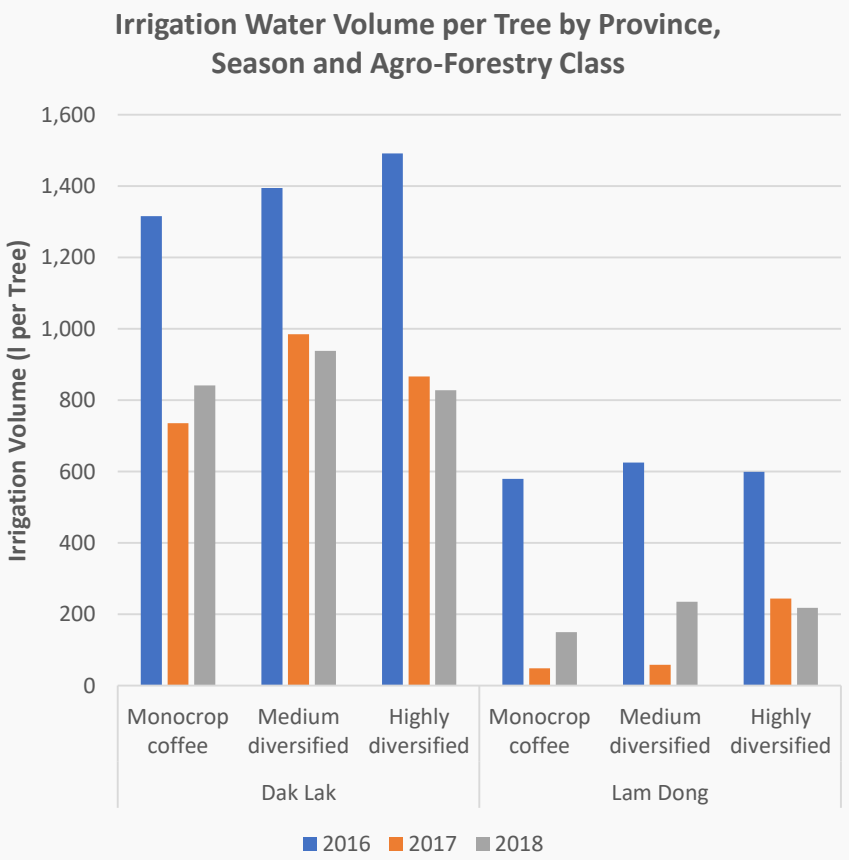


Farm management: The share of farmers who spray biocides has reduced significantly and is down to less than 10% in Dak Lak. Average working hours used for this activity are minimal and dropped significantly as well



- In Dak Lak, 9% of the farmers sprayed biocides during the past season, down from 43% in 2016.
- In Lam Dong, prevalence of spraying biocides is much higher, with 43% of the farmers using them in 2018. Yet this is a strong reduction compared to 2016, when 71% of farmers used biocides.
- Of those farmers who spray in Dak Lak, 41% of them have involvement of women in this activity, this ratio is essentially stable, with a small 3 percentage point drop to 38% in 2018.
- In Lam Dong the share of farms where women are involved in spraying activities more or less doubled from 18% to 38%, although the working hours used for it have gone down.
- Worthwhile to note is the strong reduction in the use of biocides in both provinces. In previous years we found no correlation between spraying and yield levels. And this year for Dak Lak the same holds. Of course, we cannot know the counter-factual scenario of what would have happened to the yields of farmers who sprayed, had they not done so. Still, the fact that just 9% of Dak Lak farmers sprayed while yield levels are comparable to previous years gives a strong indication that spraying is probably not needed on most farms.

Farm management: Irrigation volume per tree was reduced significantly, but 2016 was an exceptionally dry year. Changes from 2017 to 2018 are minimal, except for Monocrop and Medium diversified farms in Lam Dong



- In the absence of wide-spread water meter usage on farms, irrigation volumes are estimated by farmers themselves. At the start of the programme each farmer was supposed to have received instructions on how to use a 200 l barrel and time how long it takes to fill this with his irrigation pump. During irrigation, the farmer times how long the pump is running, divides that by the time it takes to fill the barrel and multiplies that by 200 l to estimate the irrigation water volume. If this was done properly, the volumes presented here are the best approximation possible in the absence of water meters.
- A central idea of the ISLA programme is that more diversified farming systems could use less irrigation water. We do not see this reflected in the data. Possibly, because more trees on a given area increases the total amount of evapotranspiration.

Farm management: In the Lam Dong FFB areas, irrigation is an incidental activity driven by seasonal weather patterns, while in Dak Lak nearly all farmers need to irrigate every year

- The situation in 2016 is clearly illustrated in Fig 1 which shows for that year nearly all farmers in Lam Dong irrigating, whereas in subsequent years, this dropped to 14% of farmers in 2017 and 28% in 2018.
- In Dak Lak, water use follows a normal distribution in the last 2 seasons (no extreme outliers). A proxy for reliability of irrigation data is the correlation between reported energy cost for pumping and the volume applied. In all years this figure ranges from 0.63 to 0.76, with exception of 2016 when irrigation volumes were reported on recall basis and the r-squared value was 0.20

Fig. 1 Distribution of Water Use per Ha, Lam Dong

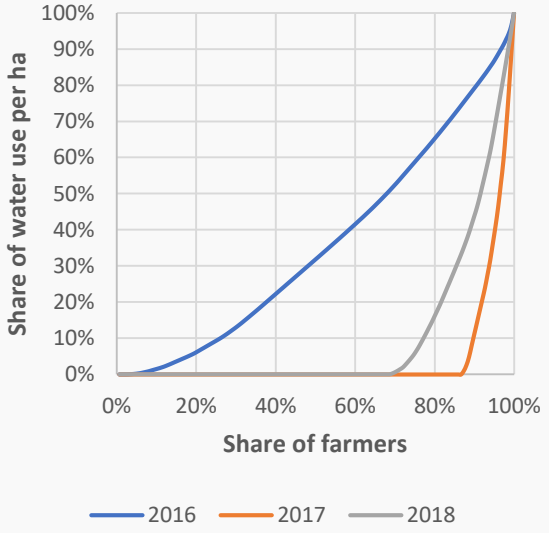


Fig. 2 Distribution of Water Use per Ha, Dak Lak

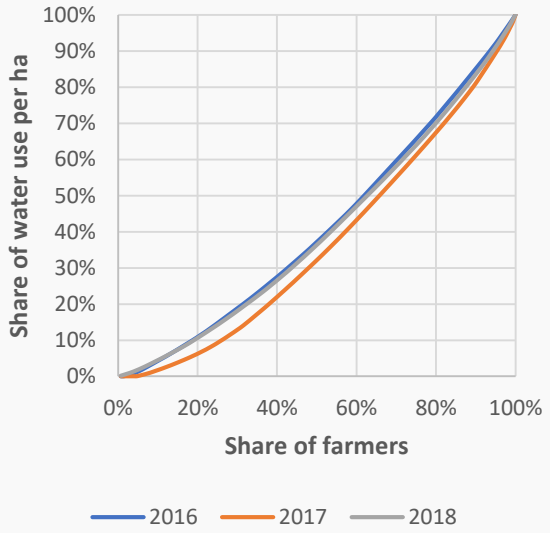
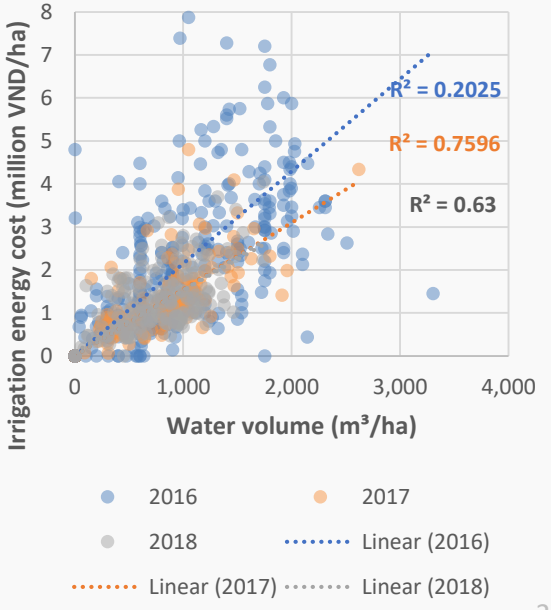


Fig. 3 Irrigation Volume versus Energy Cost by Season



Farm management: Modelling of irrigation water use per ha shows that farmers are cost-sensitive, those with higher costs per m³ water tend to use less of it

- Water saving is a priority for some stakeholders in the Vietnam coffee sector. We modelled the level of irrigation water use per ha while controlling for a range of other variables that may, or may not correlate with the use of water.
- We ran the models for Dak Lak and Lam Dong separately, as the climatological conditions vary greatly.
- We find an inverse correlation between the amount of water used and the energy cost per m³. With every 1 VND cost increment, farmers in Dak Lak show 74 liters lower water use per ha. In Lam Dong this value is 40 liters. In 2016, when coffee prices were higher we did not find this correlation.
- Some variables that we would have expected to explain (some of) farmers' water use do not: The type of irrigation system, Benefit-Cost Ratio, ethnicity, gender, age, access to training, the amount of pepper plants per ha.

Dak Lak:

- Beyond the generally applicable finding on sensitivity to costs, a few notable differences show up.
- In Dak Lak, the heavier users of water are also those who over-apply nitrogen.
- A relevant discussion that has not yet received much attention is how increasing shading levels is influencing irrigation requirements. More trees leads to more evapotranspiration which may increase irrigation requirements. Here we find that the share of non-coffee trees on a farm correlates with lower water use (albeit around the 90% confidence level), while the total number of trees per ha, including coffee, show correlates with higher water use (+328l/ha/tree)

Lam Dong:

- Aside from the cost effect, another important aspect in Lam Dong is farm size. Larger farms tend to use less water per ha. We have seen in previous analyses that farmers with larger farms economise on labour. This may also play a role here.
- Contrary to Dak Lak, the share of non-coffee trees among Lam Dong farmers shows a positive correlation with water use, i.e. farmers with a greater share of non-coffee trees, use more water per ha. Clearly, the divergence with Dak Lak on this aspect, indicates that more study is required to fully comprehend.

Farm management: Inter-communal differences can be significant, but in most places farmers appear to be converging on what are perceived to be more optimal levels of water use

- In Dak Lak, farmers appear to come closer to optimum levels of irrigation. The large differences we saw in 2016 and 2017 across the 3 communes are no longer show a statistically significant difference in 2018.
- In Lam Dong we see a similar pattern in that water volumes are lower than in 2016, with the exception of Tan Nghia commune.
- Ultimately, what matters is how much value farmers can derive from the water they have used, and on a policy level, how that value compares to values other existing or new users can derive from it. In Dak Lak we see a ranges from a little over 50,000VND profit per m³ used to just under 100,000 VND, not meaningfully influenced by the level of farm diversification.

Fig. 1

Average Water Use per Tree by Commune and Season

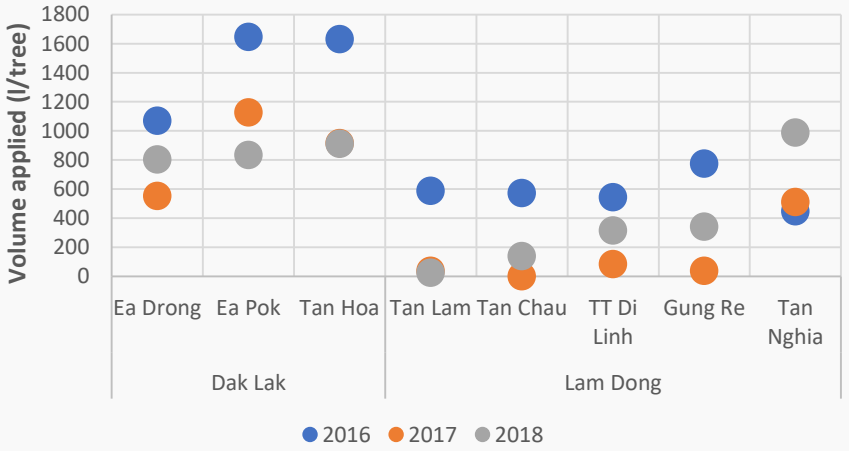
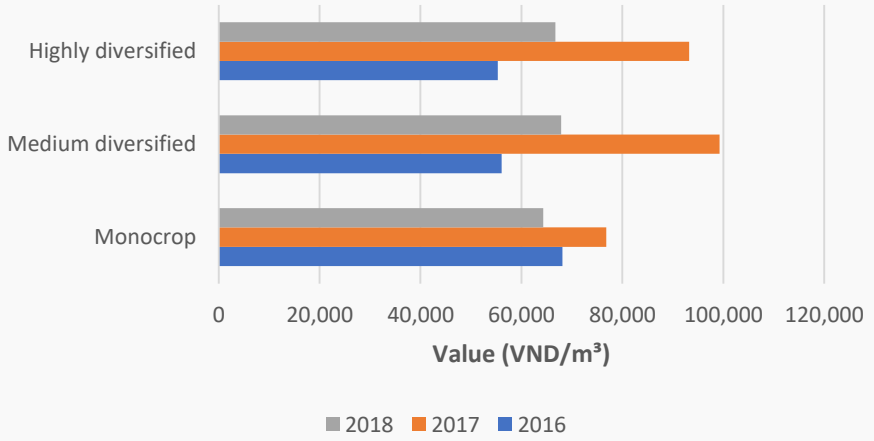


Fig. 2

Profit per m³ Irrigation Water by AGF Class and Season - Dak Lak only



Farm management: Nitrogen use efficiency has improved in 2 consecutive years, and is closing in on what we think is optimal

- The nutrient balances are calculated by subtracting the amounts of nitrogen (N), phosphorus (P) and potassium (K) contained in the fresh cherry harvest from the volume N, P and K applied through fertilisers, compost and manure. This calculation does not take into account of the efficiency of uptake, availability to the tree and losses from leaching.
- For N we suspect an over-application of 100 kg/ha should be enough to compensate for such losses. That means, the nutrient balance should be +100 kg/ha. Back in 2016, the N-balance was +151 kg/ha, but this has gone down significantly reaching a level +104 kg/ha in 2018.
- Consequently, if we calculate the amount of N used to produce 1 Mt of the green coffee, we see a reduction from 136 kg to 122 kg/Mt. The efficiency ratio improved by 6.1% and 4.6% over the past 2 years.
- Close to a third of all farmers are in what we think is the optimal N balance range from 0 to +100 kg/ha.

Fig. 1

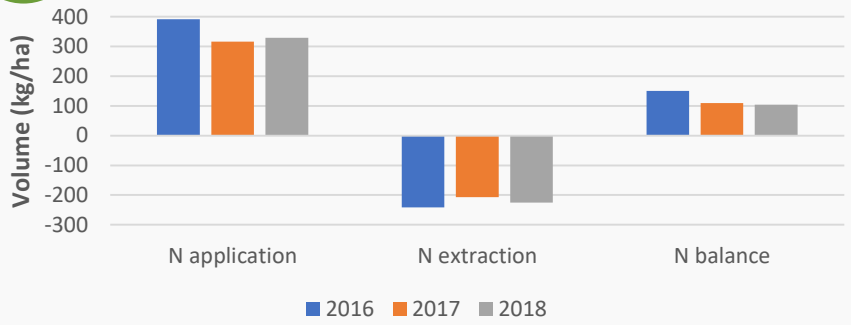
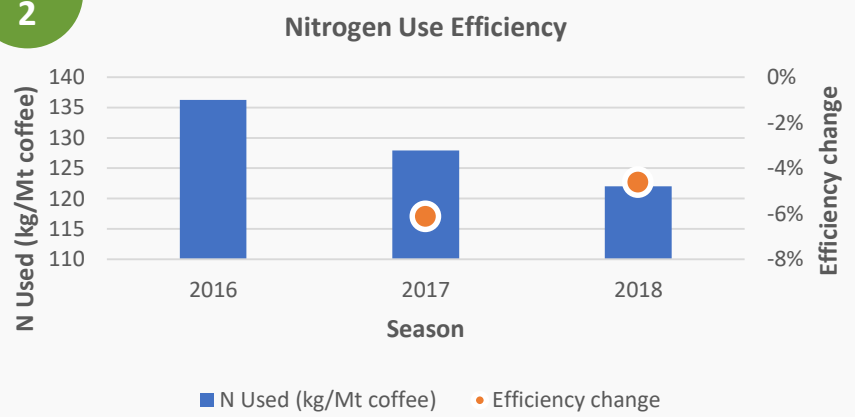
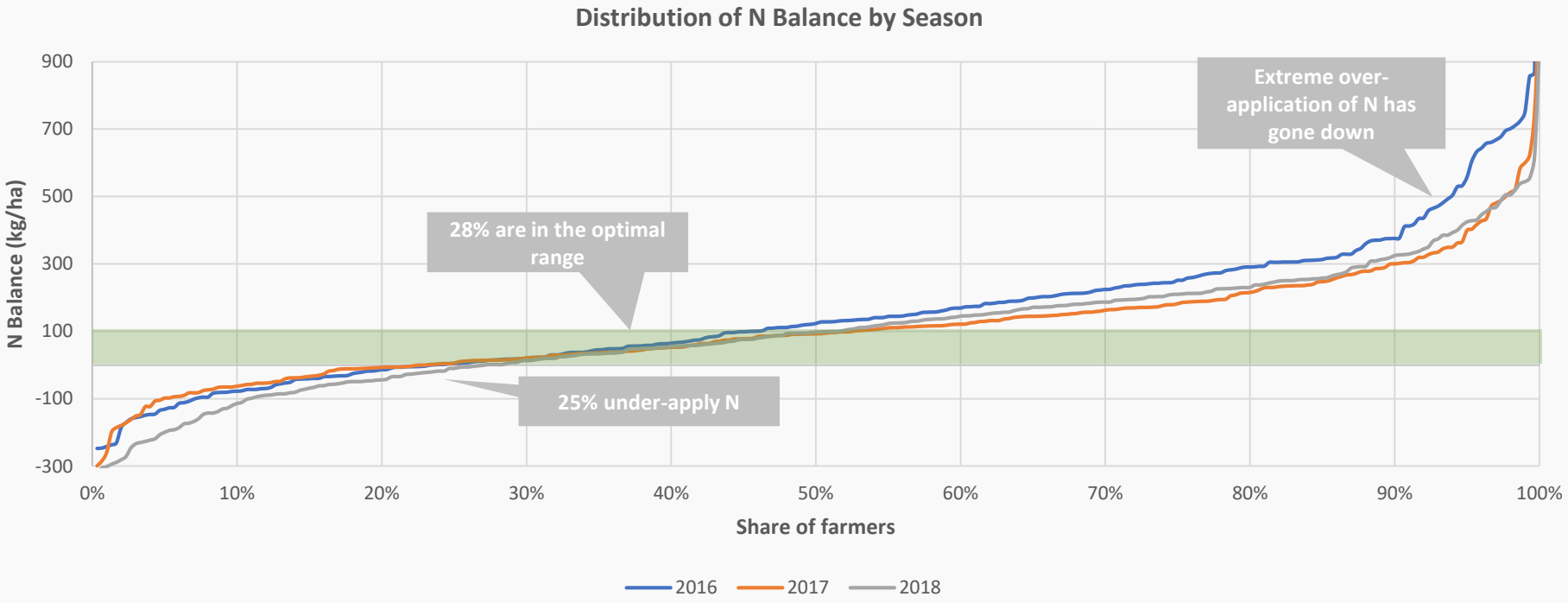


Fig. 2



Farm management: Improvements in N management are visible, extreme outliers have reduced in frequency and level of over-application

- In 2016, we saw a number of farmers with extreme levels of over application of N. A select few persist in this, but the lines for 2017 and 2018 on the right hand side of the graph have dropped, indicating that both fewer farmers are applying extreme levels of N and those that continue to apply too much, apply on average, less of it.
- Roughly a quarter of farmers remove more N during harvest than the apply, while the share of farmers in or close to the optimal range has increased by 15%.



Farm management: Phosphorus over-application has gone down steadily, while potassium has increased relative to N and P, but the balance remains negative as yields have gone up.

- In line with recommendations in earlier company reports and the first ISLA programme report[6] the over-application of P has, on average gone down significantly from +64 kg/ha to +36 kg/ha (Fig 1).
- Relative to the yields, which have gone up on average across the whole group, the level of potassium application has gone up slightly, but not significantly (Fig 2). Still, K does not display the relatively strong reduction we observe in N and P which indicates that a good number of farmers have adjusted their fertiliser formulas to maintain or increase K application levels, while economising on N and P.
- Yield modelling shows that higher K applications correlate with better yields together with a number of other agricultural practices such as pruning, so we believe it remains advisable to stimulate farmers to carefully consider their K application and ideally run some tests on their own farm with higher k applications on a small number of trees to observe the yield response.

Fig. 1

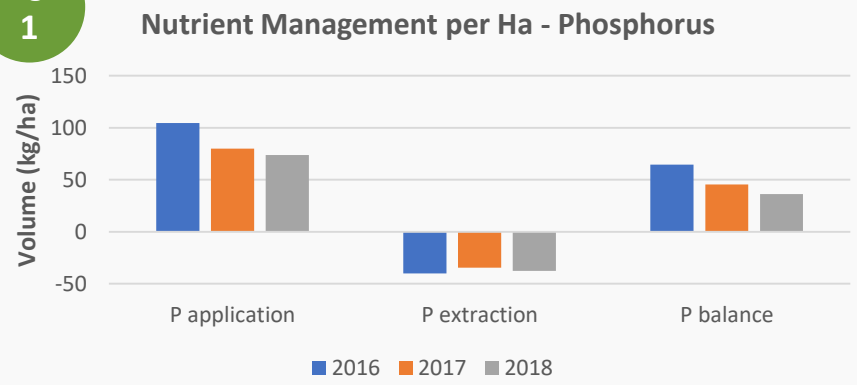
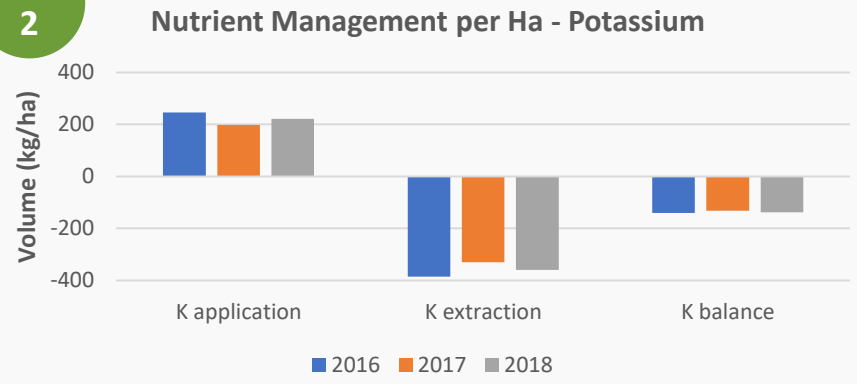


Fig. 2



Farm management: Organic matter applications are back to 2016 levels after a dip in 2017. The share of farmers using it has gone up slightly

- Average organic matter application dipped in 2017, but have recovered to about the level they had in 2016. The share of farmers using organic matter has increased to 31%, just 3 percentage points higher than in 2016 (Fig. 1).
- If we split the organic matter application levels by AGF class, we see that monocrop coffee farmers had the highest organic matter application levels during the 2016 and 2017 seasons (Fig 2). This phenomenon is driven by a number of farmers in Lam Dong who use significant volumes of manure in addition to their regular fertiliser applications.
- The correlation between manure application and yields is weak, probably because on many farms, nutrients as such are not a limiting factor and other practices like pruning have a greater effect on yield levels.
- Still, in the mid-term we would expect to see differences in yield and yield variability between farmers who have consistently applied organic matter in significant volumes over a longer period of time. We expect to conduct this analysis in the 2021 ISLA FFB report when we can draw on 5 years worth of daily records.

Fig. 1

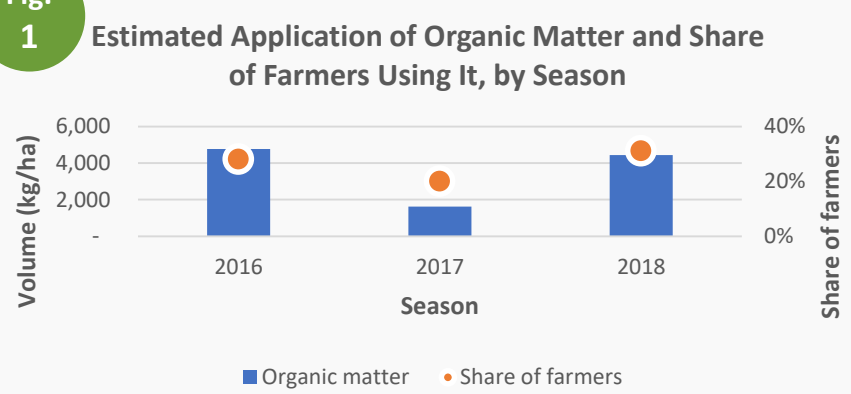
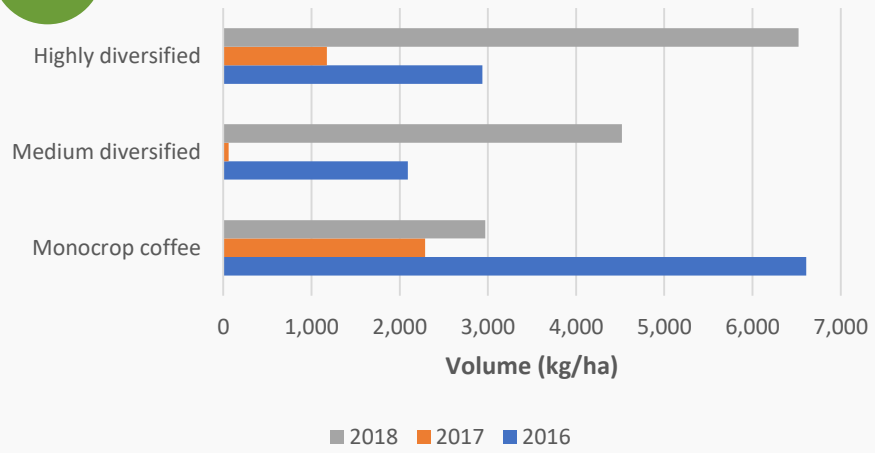


Fig. 2



Farm management: Rates of rejuvenation have declined in Dak Lak but are increasing in Lam Dong. Coffee tree stocks are either stable or growing in both provinces

- Some stakeholders in the Vietnam coffee sector are concerned about ageing plantations and an expected decline in production. In the FFB data we do not find a strong correlation between estimated year of planting coffee and productivity.
- If we analyse the rate of replanting by calculating the share of trees being replaced, then we find that in Dak Lak the rate is 2.3%, which implies that an average tree is kept in production for 37 years (Fig 1).
- In Lam Dong, the rate has picked up to reach 4.8%, up from 1.7% in 2016. At the 2018 rate, trees would remain in production for close to 21 years. In both cases the share of total production cost required to reach this rate is very manageable and we hence conclude that rejuvenation is something farmers are easily capable of financing with owner's equity. Tree stock numbers are bearing this out (Fig 2&3), with steady or growing stocks for all farmers.

Fig. 1 Tree Stocks and Replanting Rates by Province and Season

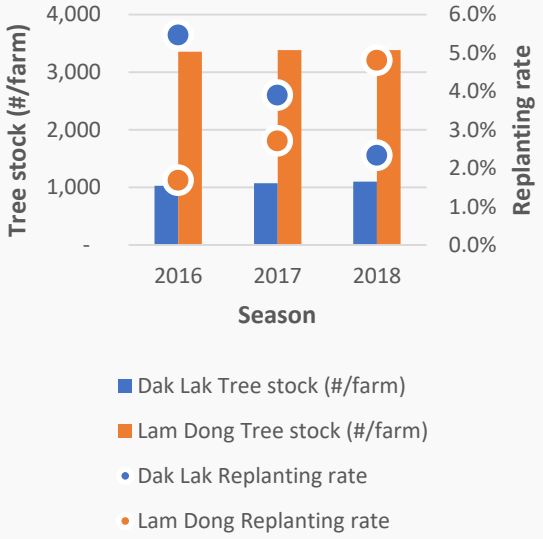


Fig. 2 Tree Stocks and Replanting Rates by Season, Lam Dong

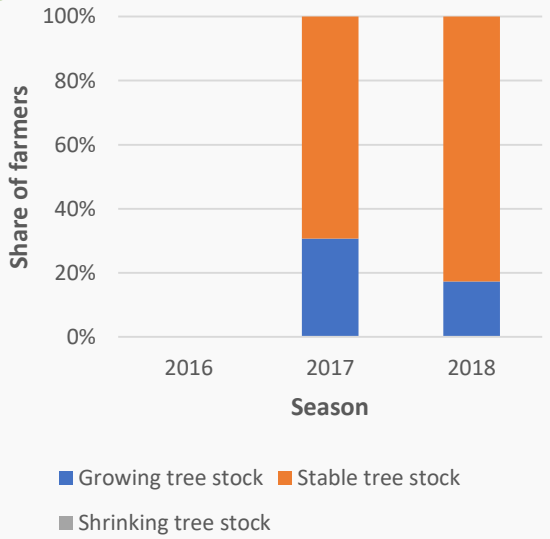
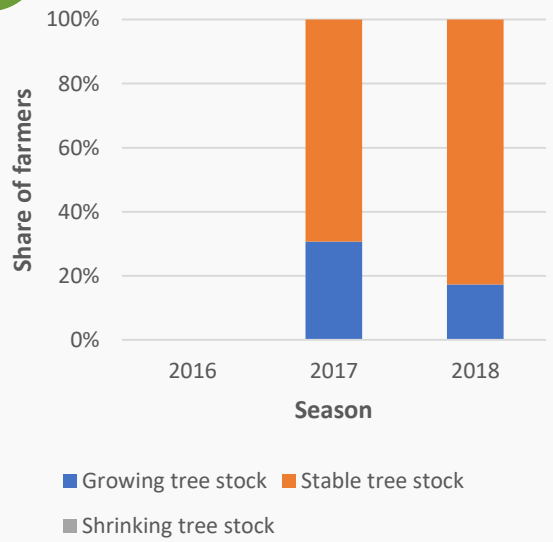


Fig. 3 Tree Stocks and Replanting Rates by Season, Dak Lak



Farm management: The use of hazardous and banned biocides has gone down significantly. No biocides banned by national regulations are used

- The use of biocides has gone down in both provinces (page 25), and so has the use of most hazardous pesticides. In Lam Dong we still find a few isolated cases of farmers who have used biocides banned by standards, but these really are just a few farmers. Also the use of the Highly Hazardous Pesticides (HHPs) group of pesticides, which is allowed but carries a greater health and environmental risk has gone down by almost a factor 5 in Lam Dong and is nearly absent in Dak Lak (Fig 1).
- Consequently, cost and application volume data show a similar downward trend (Fig 2&3).

Fig. 1

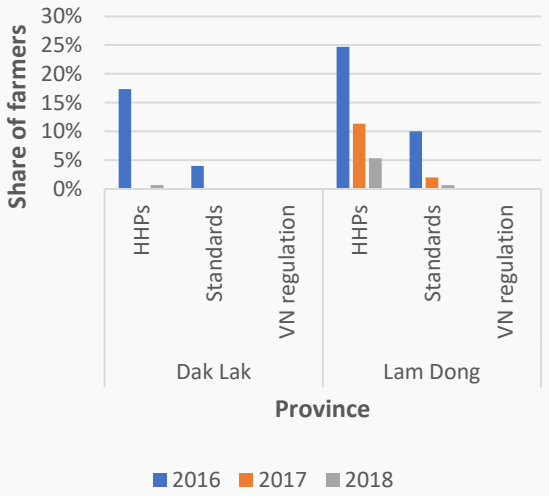


Fig. 2

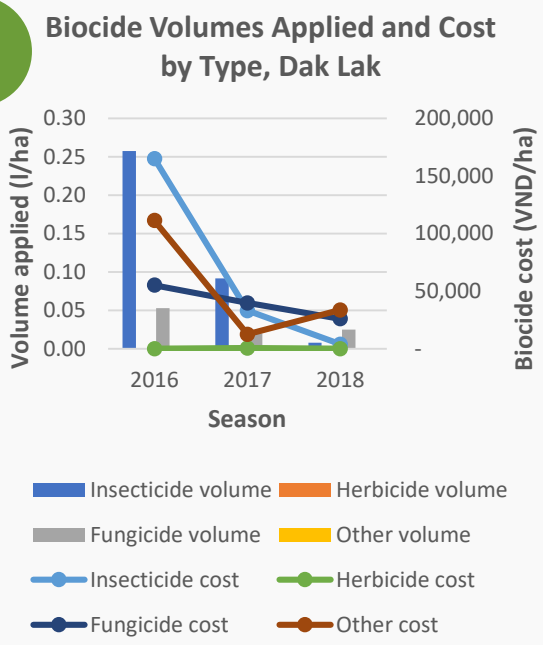
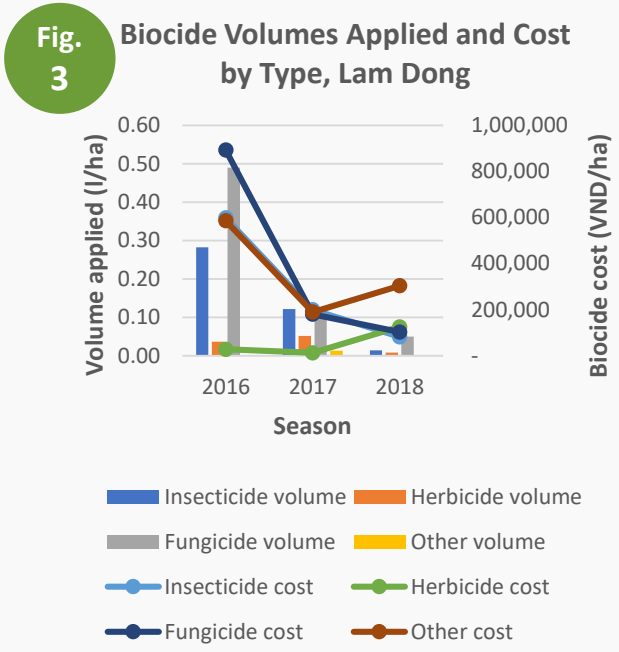


Fig. 3



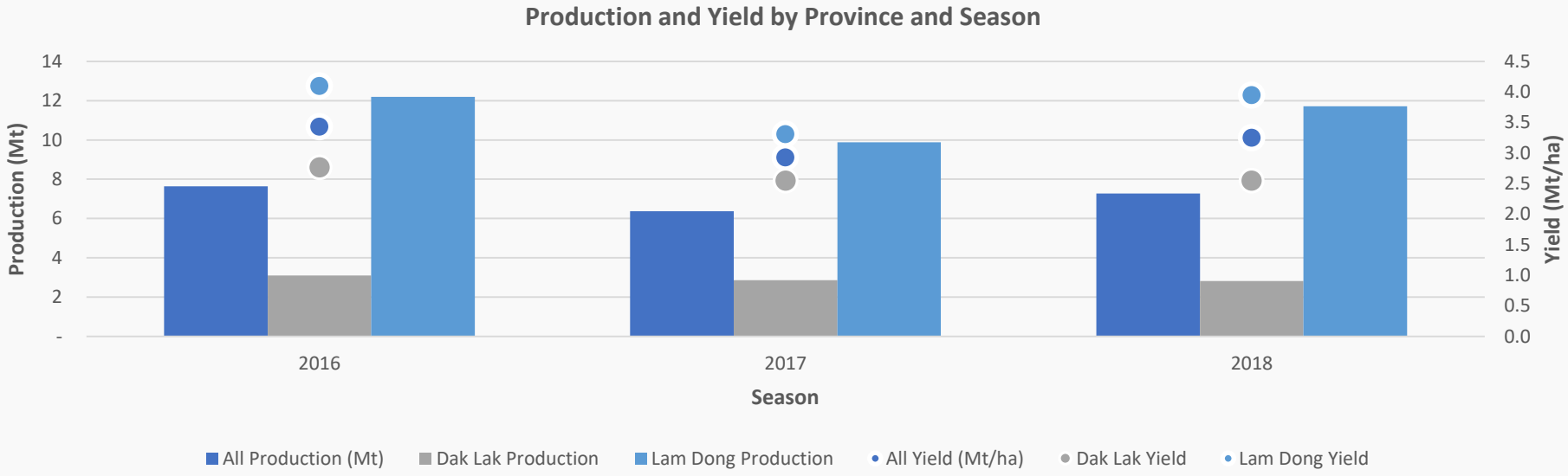
Farm management: The issue with using banned biocides pertained to 20 products and 14 active ingredients in 2016, but is now down to a single product called Hinosan

Trade name	Active ingredient 1	Active ingredient 2	Manufacturer	2016		2018	
				UTZ & 4C	National law	UTZ & 4C	National law
2,4-D	2,4-D		Vietnam		X		
Ambush	Permethrin		Don't know	X			
Bop 6EC	Carbosulfan		Don't know	X			
Gammalin	Lambda-cyhalothrin	Profenofos	Hoa nong lua vang	X			
Hinosan	Edifenphos		Unknown			X	
Karate	Lambda-cyhalothrin		Syngenta	X			
Ke huy diet	Imidacloprid	Lambda-cyhalothrin	Kahumate	X			
Map permethrin	Permethrin		Mappacific	X			
Marshat 2SC	Carbosulfan		Don't know	X			
Mokak	Ethoprophos		Don't know	X			
Ofatox	Fenitrothion	Trichlorfon	BVTV 1 trung ương	X			
Quick removal	Lambda-cyhalothrin	Chlorpyrifos	Don't know	X			
Supracide 4EC	Methidathion		Don't know	X			
Suprathion 4EC	Methidathion		Isxaren	X			
Suprathion 4EC	Methidathion		Syngenta	X			
Tasodant-6EC	Permethrin		Don't know	X			
Thio-m	Endosulfan		Trung quoc	X	X		
Vi BenC 5BTN	Benomyl		Don't know	X			
Vibasa	Carbofuran		Vietnam	X	X		
Vibasu 1H	Carbofuran		Don't know	X	X		
Vifu super.5GR	Carbosulfan		Vipesco	X			

Results
Production

Production: Average productivity is 3.95 Mt green bean per ha in Lam Dong and 2.55 Mt/ha in Dak Lak. We find a negative correlation between farm size and productivity

- In many origins one can find a significant correlation between farm size and productivity in which larger farms tend be less productive. This is not the case in Vietnam, which indicates that farmers with larger land holdings have sufficient capital and managerial acumen to manage larger scale operations. In some communes in the FFB sample this phenomenon does apply, but on average across the entire sample it does not.
- Production levels in Lam Dong are close to where they were in 2016 at nearly 12 Mt per farm. This high level suggests that the Lam Dong project has focussed on larger and better off farmers.
- We expect the smaller farms to be the first to show declining yields in times of persistent low coffee prices. Dak Lak yield and production levels are slightly below their 2016 levels, but not significantly so. Given the deteriorating market conditions over this time frame that's a welcome sign of farmers' resilience.



Production: Normally, around half the farmers has a higher yield than the year before, the other a lower yield. Lam Dong shows an odd pattern in this regard.

- Lam Dong shows an odd bi-annual pattern than one would normally expect to see in arabica coffee, not in robusta (Fig 1&2).
- The correlation in Lam Dong between high yields one year and low yields the next is strong at 0.64.
- We suspect that trees yielding >4 Mt/ha are being pushed to their limits.

Share of farmers		Season	
Province		2017	2018
Lam Dong	Higher yield	7%	77%
	Lower yield	93%	23%
Dak Lak	Higher yield	48%	47%
	Lower yield	52%	53%

Fig. 1

Fresh Coffee Cherry Yield in 2017/18 versus 2016/17 by Farmer and Province

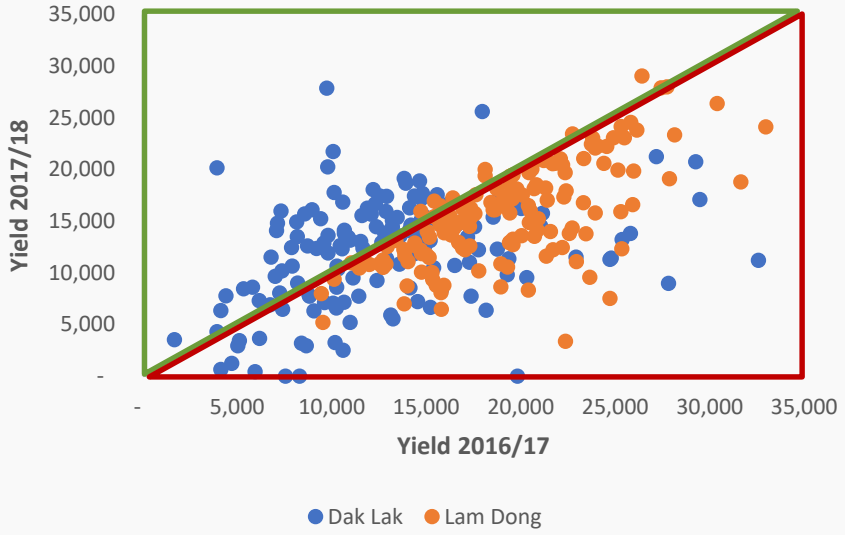
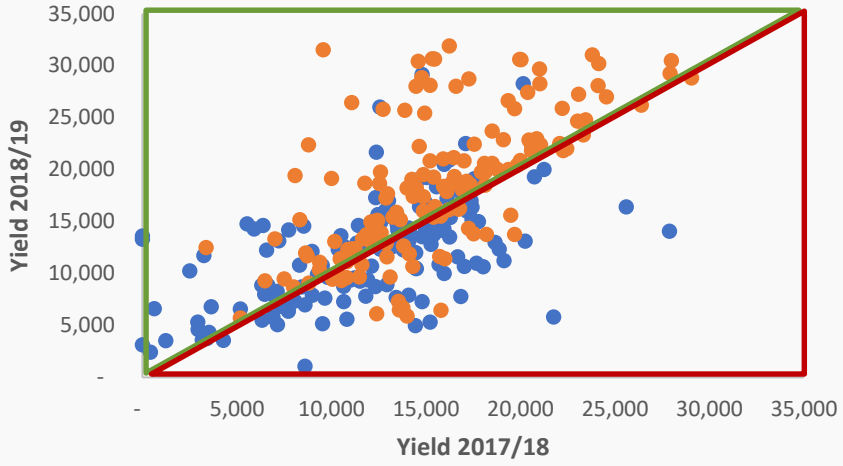


Fig. 2

Fresh Coffee Cherry Yield in 2018/19 versus 2017/18 by Farmer and Province



Production: Farm sizes alone do not explain the supply concentration, yield levels play an important role too

- Supply concentration has increased among the top 20% of largest producers. Their market share increased by 11% from 30.7% of total supply to 34.1% of supply.
- The share of the bottom 20% smallest suppliers has remained steady ranging from 8.6% in 2016 to 8.7% in 2018.
- The small contribution among the bottom 20% is in part explained by smaller farm sizes, but this is not the whole story. Yield levels in the top-tiers are higher by a very significant margin. Farmers in the top-20% group reach yield level of 4.74 Mt/ha, 10% higher than their already high yield levels of 2017.
- The yield fluctuations we saw on the previous page are most pronounced among the middle group, who show staggering changes from year to year.

Fig. 1

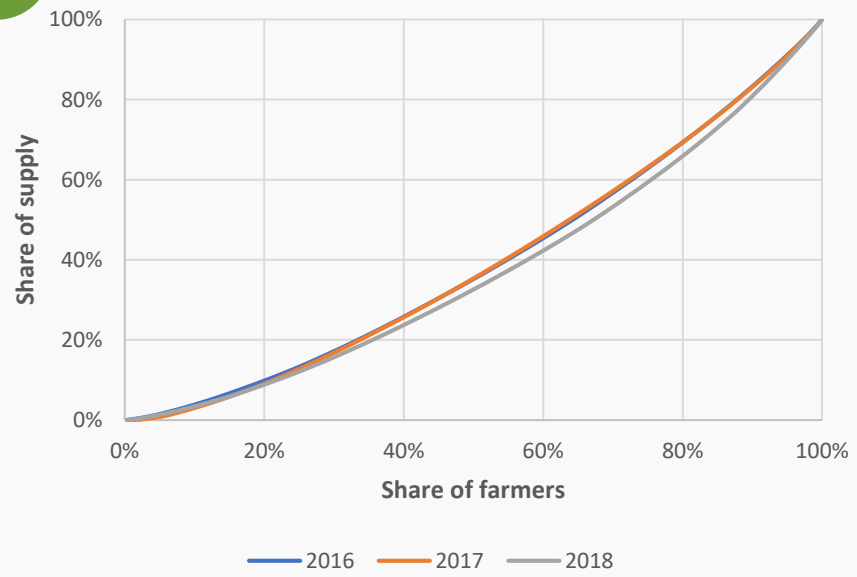
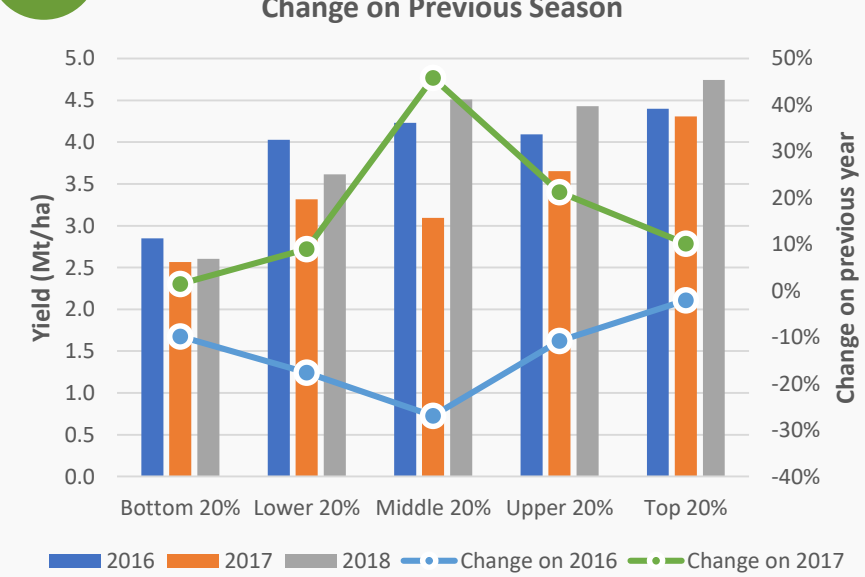
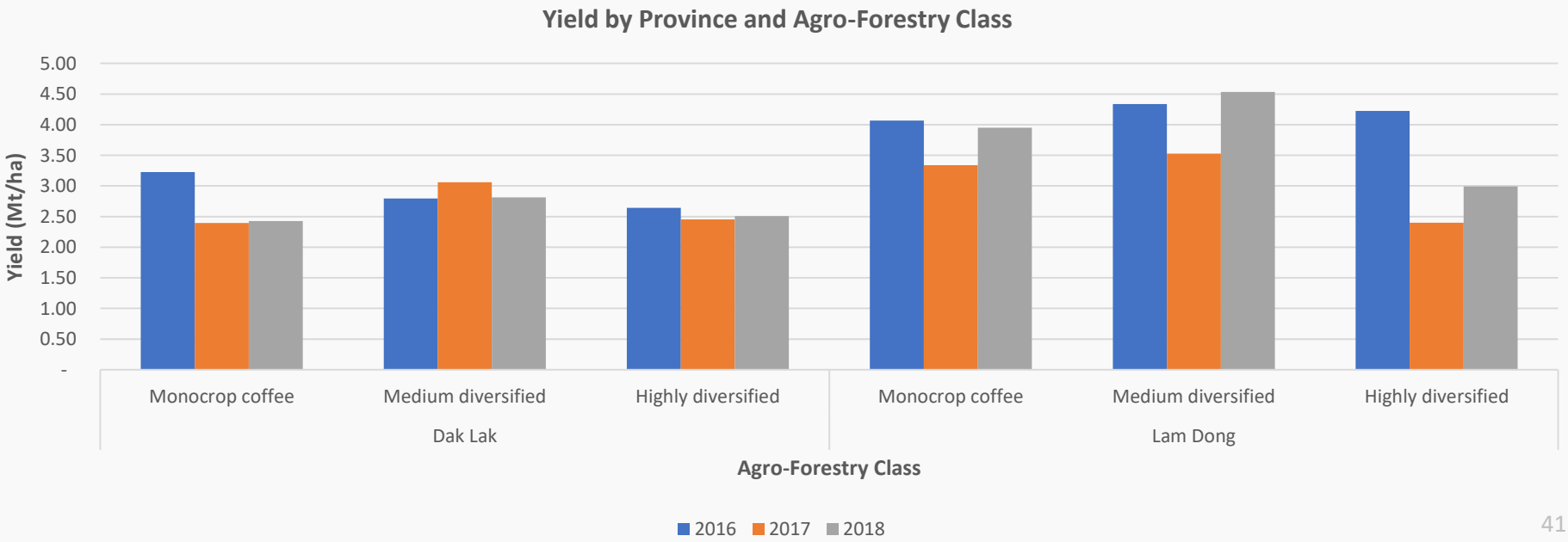


Fig. 2



Production: We find no significant differences in yields between the 3 agro-forestry classes, except in Lam Dong where diversified farms show lower yields in 2017 and 2018

- A central pillar of the ISLA programme is that promotion of more diversified farming creates more resilient farms, both economically and from a climate change perspective.
- In Dak Lak this seems to work well, and there a higher degree of diversification in fact predates the start of the ISLA programme. In Lam Dong the picture is more mixed, with Highly diversified farms showing significantly lower coffee yields during the 2017 and 2018 crops.
- We are not yet certain why this is, but suggest the programme to look into this and try to do some more validation of the approach it is promoting.

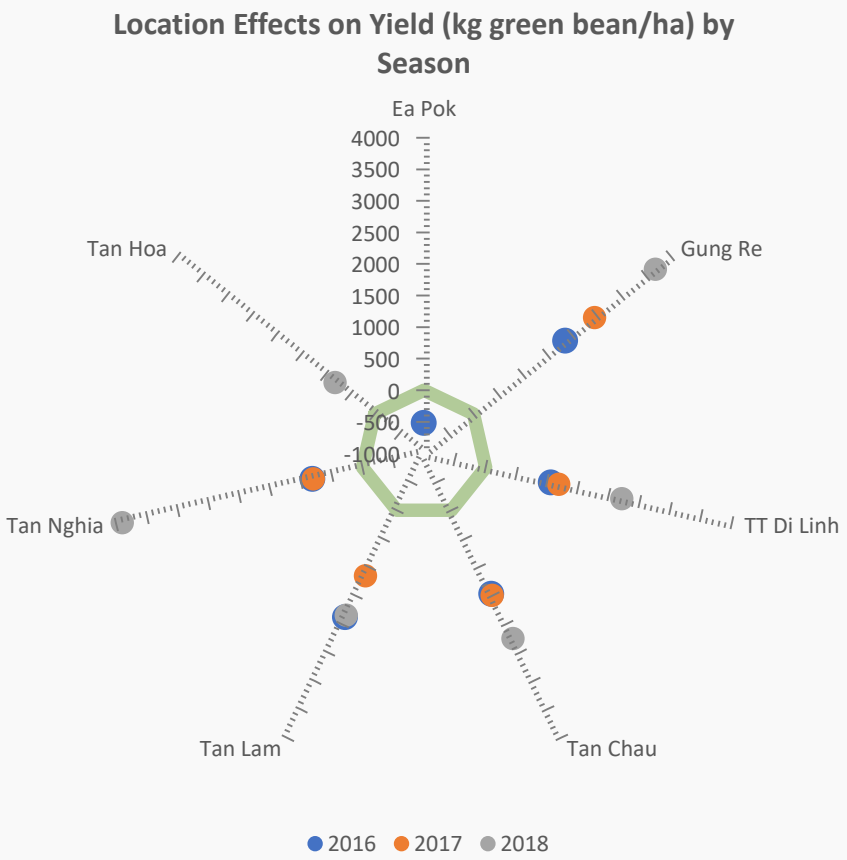


Production: We model yield and present groups of variables for location, socio-economic conditions and farm management and their effect sizes

- We constructed a linear regression model with 22 variables that we hypothesise may correlate with yield. The model was set to run at a confidence level of 95% for each of the years for which we have data available.
- Of the variables included, one is a dummy variable for each of the 8 communes, where we take Ea Drong, alphabetically the first commune on the dataset, as the base against which the location effects of being located in another commune is measured.
- Seven variables are related to farmers' socio-economic conditions: ethnicity, gender, age, number of years growing coffee, education level and coffee area.
- Fourteen deal with farm management aspects. These are: N, P and K applied, organic matter applied, irrigation water volume, pesticide cost, weeding equipment energy cost (a proxy for the use of brush cutters instead of herbicide), and labour for fertilising, pruning, pruning shade trees, basin maintenance, weeding, stumping and grafting.
- The following slides discuss the findings. We present the results for 3 years in radar charts with dots showing if a variable had a significant effect in a given year. In some years a variable has an effect, while in other years the same variable does not. Hence not all plotted variables have a value in each of the 3 years. In addition to significance we also show the effect size, i.e. how much does yield change (measured in kg green bean per ha) with each additional unit of a variable with all else being equal. Dots inside the green circle have a significant negative effect, those outside it, a significant positive effect.
- The model appear to gain in robustness over time, in part we suspect because of better quality data being provided by farmers after the first year, and we hope, because of an optimisation of farm management over time by at least a share of the farmers. In the first 2 years r-squared value was comparable at 0.41 in 2016 and 0.39 in 2017, while in 2018 it reached 0.61.
- Note that this model does not incorporate weather data. If that were included we suspect the explanatory power would increase.

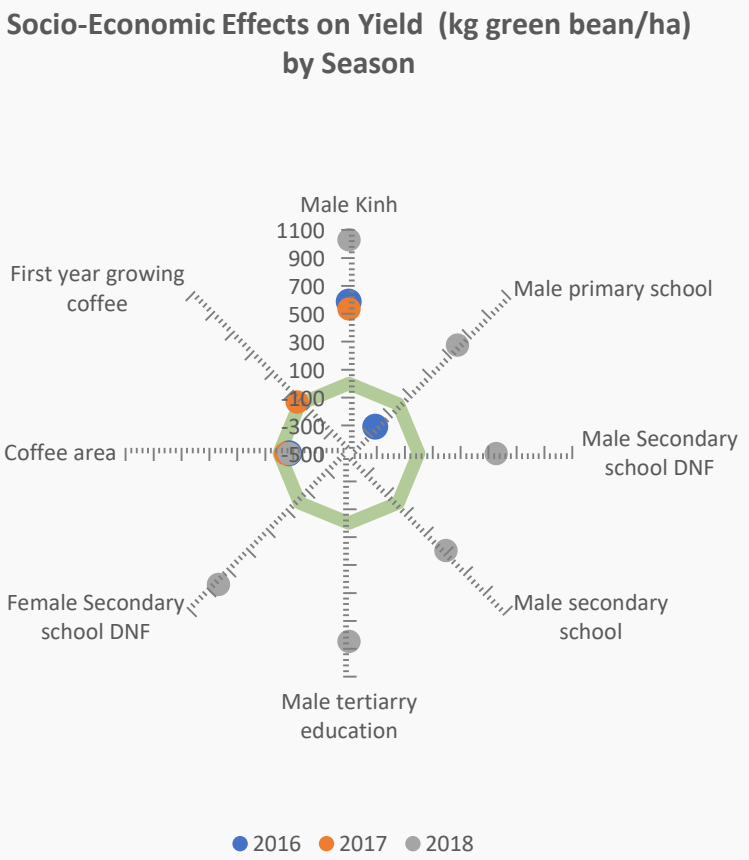
Production: Location effects are significant in all years for communes on Lam Dong province

- The scale on the axes in this graph (and the 2 that follow on the next pages) show the effect size on yield in kg green bean per ha if the variable plotted on that axes changes by 1 unit. Units of variables are show in the axes labels where applicable)
- Bearing in mind that Ea Drong in Dak Lak province is the base commune against which the effects of the others are measured, we find, unsurprisingly, significant effects in each year for each of the communes in Lam Dong province.
- What we can also see from this figure is that in 2016 Ea Pok commune (also in Dak Lak) performed significantly worse yield-wise than farmers in Ea Drong, while Tan Hoa farmers did better than those in Ea Drong in 2018.
- Needless to say, recommending Dak Lak farmers to move to Lam Dong is not very helpful. Still, the location effects matter, as they explain a part of what is happening with variations between farmers on yields.
- The next slides show socio-economic and farm management variables and how these correlate with yield *while* controlling for location effects.



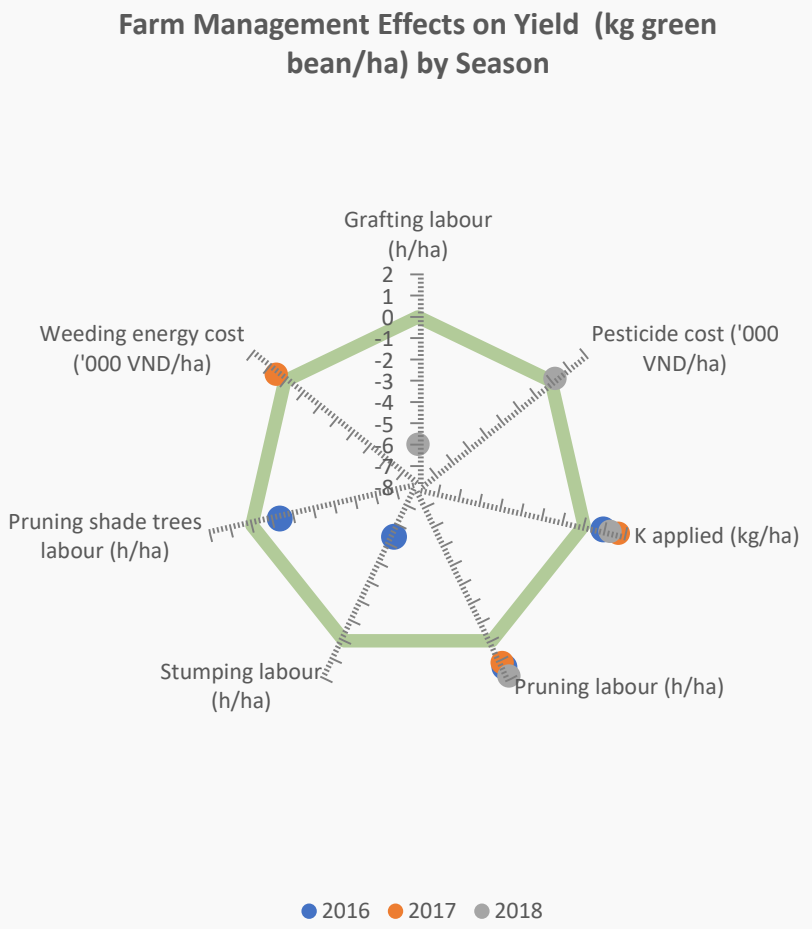
Production: Farming households of whom the male belongs to the Kinh majority group show consistently higher yields. In 2018, the effects of education become significant and large.

- Farmers that belong to the Kinh majority show consistently higher yields. This also applies to mixed households where the male is Kinh and the female belongs to one of the ethnic minority groups. We do not have farmers in our sample where the female is Kinh and the male belongs to a minority group, so this configuration can not be tested.
- We also see that larger farmers show consistently lower yield levels, the effect size range from -217 to -344 kg/ha with each additional ha of land under coffee.
- We are a bit surprised by the sudden importance of education levels to explain yield in 2018. The base level for education are farmers who have not enjoyed formal education at all, then we have dummy variables for primary (finished, not finished (DNF)), secondary (finished, DNF) and tertiary education. All the educated groups are outperforming the group without formal education, at least the males are. Perhaps in time of low prices and tighter margins, education can give farmers an edge over non-educated peers. If so, then the effect should disappear again when market conditions become more favourable. We can only speculate, but it certainly is intriguing.



Production: Pruning and K applications continue to be the management aspects that are limiting and where most farmers can make the largest improvements

- If there is only one thing you can do as a farmer (aside form harvesting that is), then prune! Pruning shows up consistently each year as the single largest explanatory variable for yields. Every hour spent pruning correlates with 5.2 to 8.6 kg green bean per ha depending on the year.
- The effect-size of K application is also significant and positive with +0.93 to +1.65 kg/ha with every additional kg of K applied. As we saw in the Farm Management section, the average K balance is negative, indicating that on average farmers do not apply enough K. The model on yield presented here confirms this and shows that farmers who are applying higher levels of K tend to get better yields.
- A kg of Kali cost around 6,800 VND/kg and contains 58% of K. This means an additional kg of K costs 11,724 VND, and yields a return of [1.24*37,000VND=45,880 VND/kg K applied]*. This gives the average farmer more than enough margin to do such an investment and spend some time on the application
- Activities around grafting and stumping show significant negative effects, as one would expect.
- Intriguing is that energy cost spent on weeding shows up with a significant positive effect in 2017. Every 1000 VND spent correlates with +0.53 kg green bean per ha *ceteris paribus*. This variable serves as a proxy for the use of brush cutters for weed control. Farmers using these keep their top soil covered, a general sustainability recommendation, and this seems to pay off, although the effect is not significant in each year.

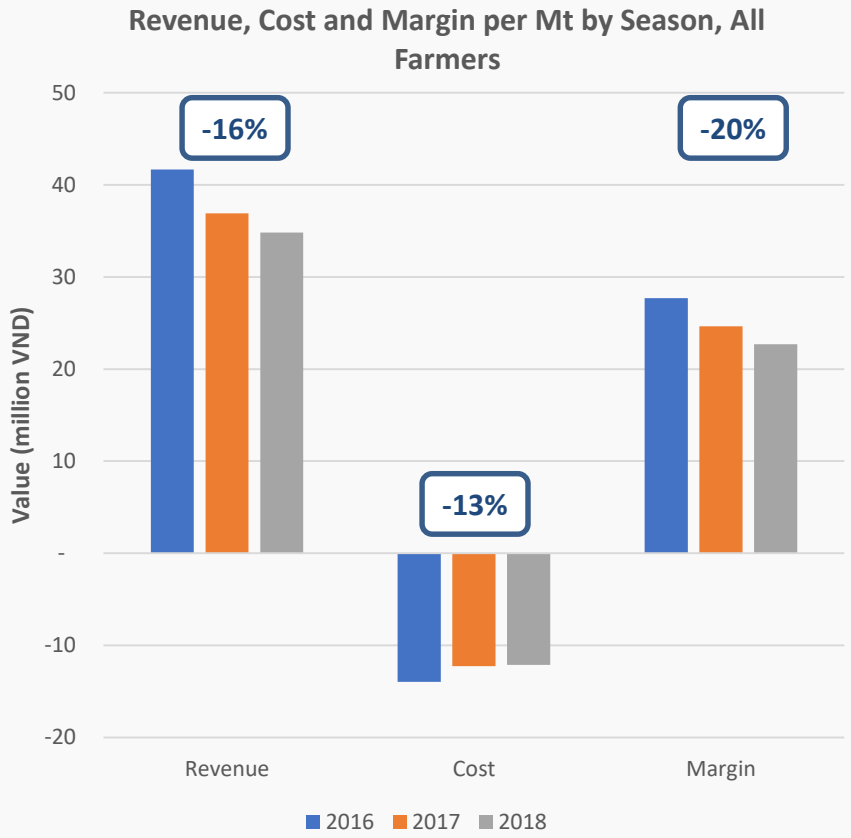


*1.24 and 37,000 are the average effect size and coffee price over 3 years

Results
Farm economics

Farm economics: Prices affect margins, but optimisation of investment has offset price decline to some extent

- The reduction on coffee price has affected farmers' revenues and explains a large part of the 16% drop in revenues from 2016 to 2018. Coffee prices over this timeframe dropped from an average green bean price received by FFB farmers of 41,660 VND/kg in 2016 to 36,133 in 2017 and 33,807 in 2018.
- Farmers have responded in part by optimising their investment levels. In 2018, cost per Mt green coffee went down by 13% compared to 2016, but still profit margins on average decreased by 20% over the same time frame.
- We do find that beyond the initial investment adjust that took place in 2017, farmers apparently did not see much scope to make further reductions in 2018. In 2016 farmers still spent 13.96 million VND/Mt, while in 2017 and 2018 this was roughly similar at 12.25 and 12.13 million VND/Mt respectively.
- Please note that these cost levels do not include the opportunity cost for household labour, but rather plot actual out of pockets payments.



Farm economics: Cost reduction was strongest in Lam Dong, consequently, margin drop there was less severe than in Dak Lak and was observed only in 2017

- Figure 1 shows the same graph as on the previous page, but then only for farmers in Lam Dong, while figure 2 shows the same for Dak Lak.
- Lam Dong farmers made their largest cost adjustment from 2017 to 2018. They started of at a cost levels of 11.68 million VND/Mt, and only in 2018 did they make a significant change down to 9.34 million VND/Mt.
- In part their lower cost levels per Mt coffee are explained by their higher yield levels (both between 2017 and 2018 as well as in comparison to Dak Lak. Their cost levels per ha (not shown here are in fact higher).
- Consequently, their margin drop, while still large, was contained to -16% from 2016 to 2018, while in Dak Lak farmers saw a -20% decline.

Fig. 1

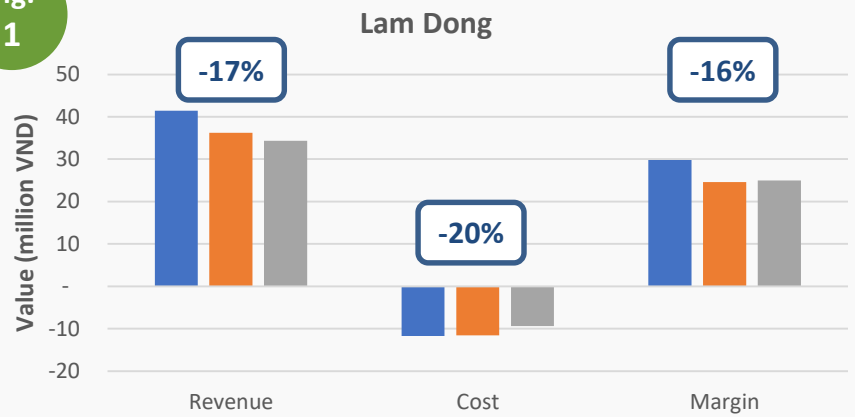
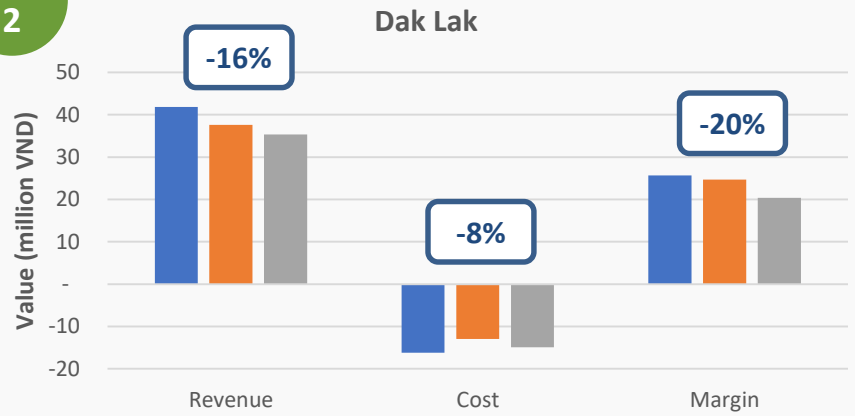


Fig. 2



Farm economics: Production cost optimisation through 16% lower fertiliser investment and 17% lower hired labour cost in Lam Dong. Dak Lak farmers reduced biocides and energy cost

- Most of the cost savings in both provinces were generated by saving on fertilisers, but in 2018 fertiliser cost levels in Dak Lak jumped back to close to where they were in 2016.
- We could earlier see that the excess of nitrogen application has on average been reduced and the economic effects are noticeable, especially in Lam Dong, where earlier, excess application was also most prevalent.
- We see that in both groups energy costs, which is mostly used for irrigation, have decreased after the dry year in 2016 which required significantly larger water volumes to meet (perceived) crop requirements.
- While pesticide costs were never a large expenditure in among FFB farmers in either province, we see it almost disappear in the 2017 and 2018 seasons.

Fig. 1

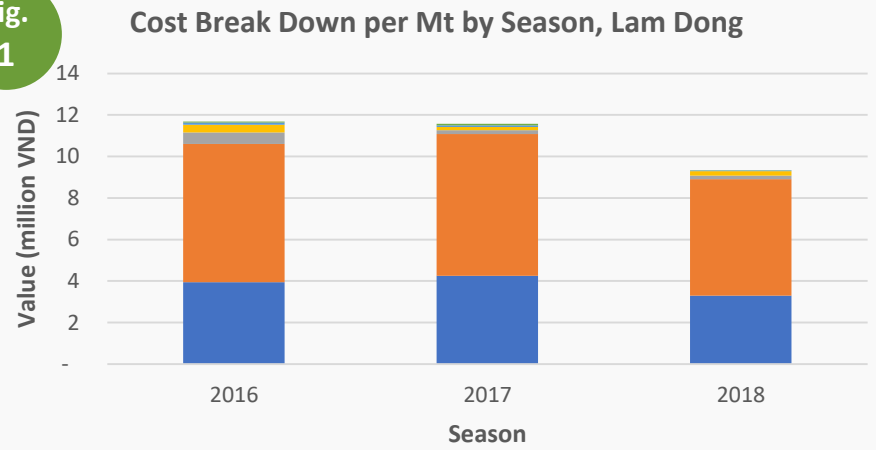
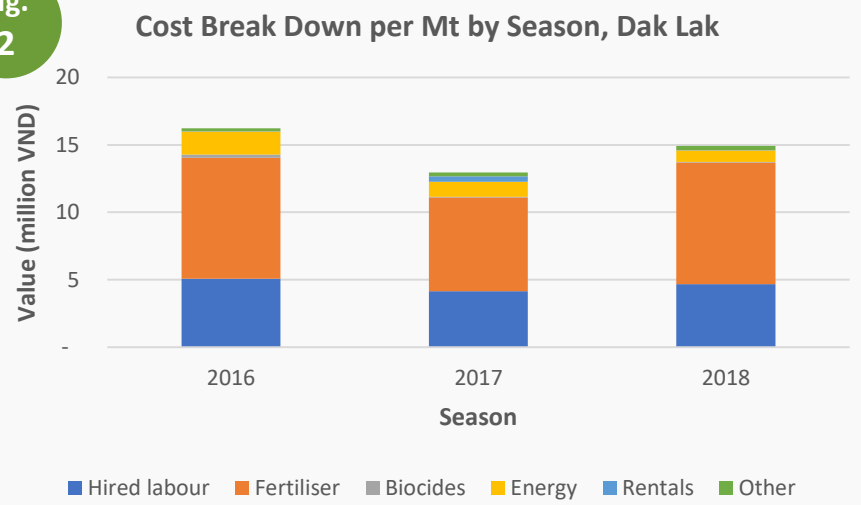
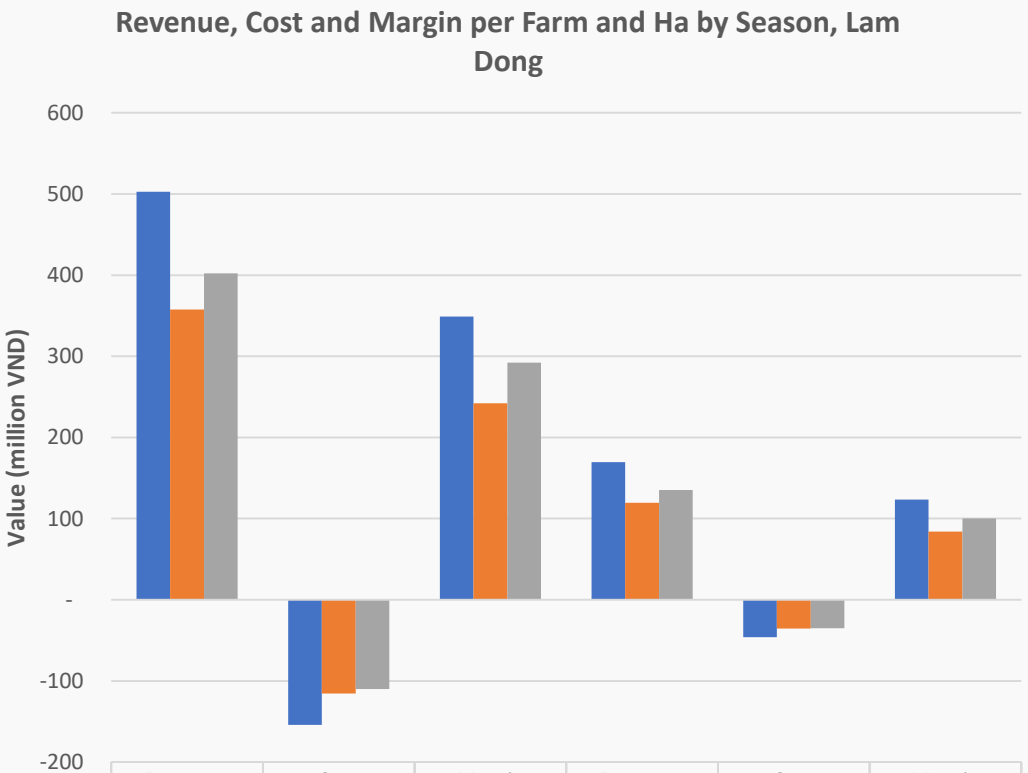


Fig. 2



Farm economics: Cost savings in Lam Dong are even more significant when viewed per ha. The drop from 2016 to 2018 amounts to 24%

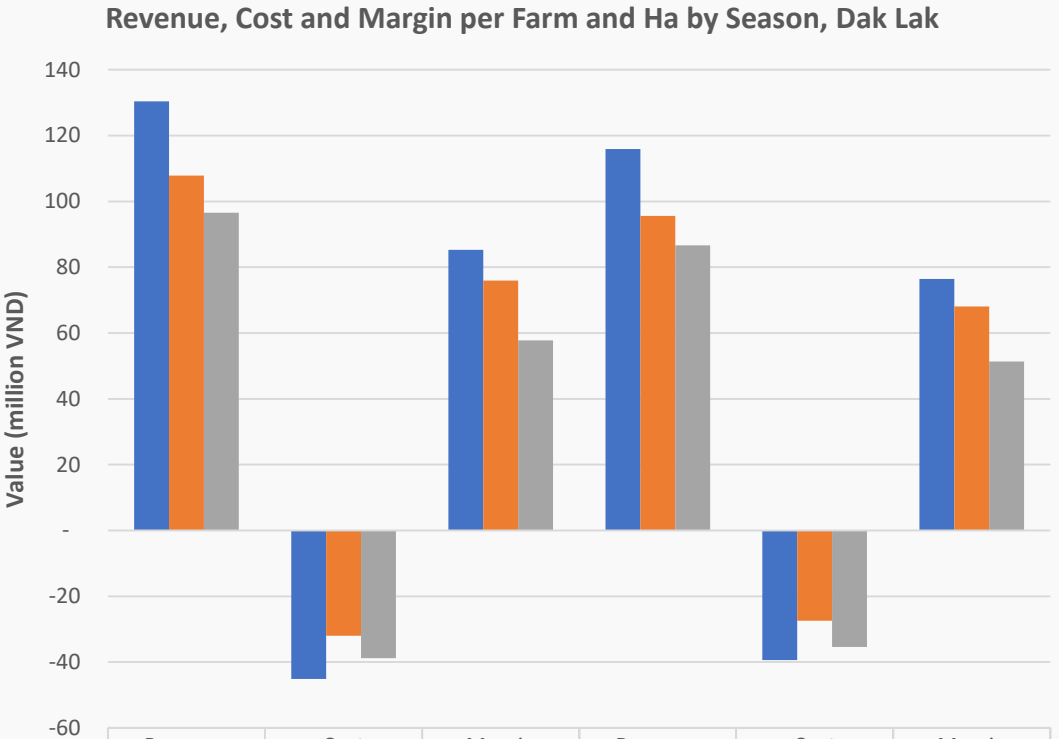
- The drop in yield levels in Lam Dong (see production section), exacerbated the price drop effect in 2017. That year, for farmers in Lam Dong, amounted to a perfect storm, with margins per farm more than 100 million VND lower. Despite lower prices in 2018, farmers were able to maintain their investment levels and the higher average yields achieved helped with a significant margin recovery of 50 million VND per farm.
- This helps to illustrate the contrast between the farmers participating in the FFB between the 2 provinces. The margin recovery of 50 million VND in Lam Dong is almost as much as the *total* margin that the average farmer in Dak Lak achieves.
- On a per ha basis cost levels between the 2 provinces are now pretty much aligned, averaging around 35 million VND/ha without accounting for opportunity cost of household labour.



	Revenue	Cost	Margin	Revenue	Cost	Margin
	Per farm			Per ha		
2016	502,692,807	-153,926,137	348,766,670	169,709,303	-46,097,258	123,612,045
2017	357,539,079	-115,437,347	242,101,732	119,686,639	-35,568,853	84,117,786
2018	402,000,342	-109,914,029	292,086,313	135,378,338	-35,109,571	100,268,767

Farm economics: Profit margins per ha dropped even stronger than the per Mt values, farmers in Dak Lak earned 32% less in 2018 compared to 2016

- Profit margins dropped, while yield levels are back to their 2016 levels. Despite some cost savings, average margins per farm dropped by 32%, much of this as a result of lower prices.
- Had farmers managed to maintain their 2017 cost levels of 27.45 million VND/ha, then the margin drop would have hurt less but would still have reached a massive 24%.
- With average margins now at 57 million VND/farm, we suspect a large share of farmers are close to or below the poverty line.
- The small farm sizes in Dak Lak do not help in this respect. While Lam Dong farmers suffer the same low coffee prices, their larger farm sizes allow them to still generate a relatively high income.



	Revenue	Cost	Margin	Revenue	Cost	Margin
		Per farm			Per ha	
2016	130,425,553	-45,169,949	85,255,605	115,887,334	-39,426,725	76,460,609
2017	107,869,454	-31,977,217	75,892,237	95,531,676	-27,452,540	68,079,136
2018	96,585,651	-38,855,787	57,729,864	86,657,336	-35,371,581	51,285,755

Farm economics: As a result, the Benefit-Cost Ratio (BCR) is stable (ish) in Lam Dong, whereas farmers in Dak Lak show a worsening situation.

- The BCR is calculated by dividing the profit margin by the total cost. The resulting value shows how much was earned on every VND invested.
- An important question we asked back in 2017 and to which we have not yet found an answer is at what BCR level does a farm cease to be viable? And for how long should that situation persist before a farmer moves to another (set of) crop(s) or another line of work?
- In Dak Lak (Fig 2) we now see 70% of farmers earning less than 2 VND for every 1 VND invested plus their own labour. In Lam Dong, the combination of cost reduction and improved yields have reduced the share of farmers with a BCR<2 (Fig 1).

Fig. 1

Distribution of Benefit-Cost Ratio by Season, Lam Dong

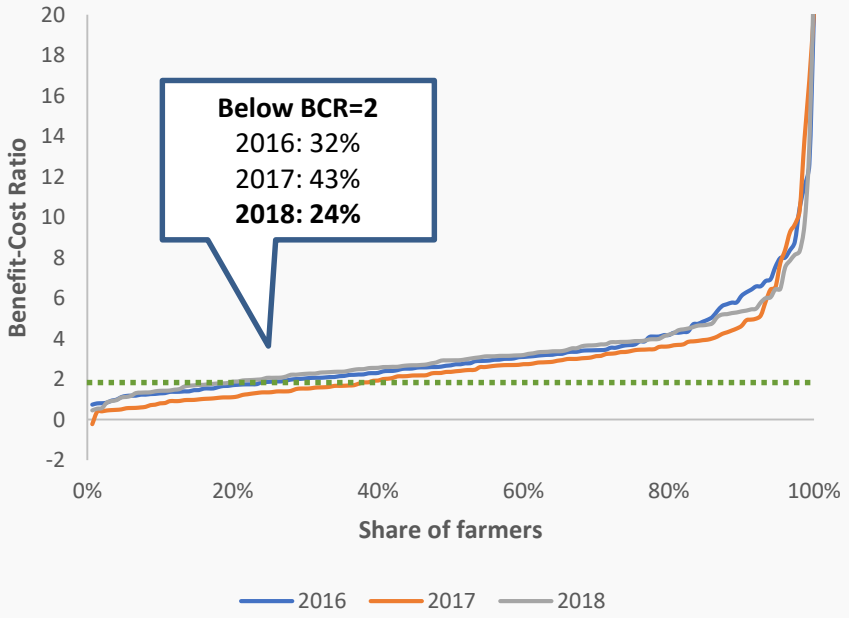
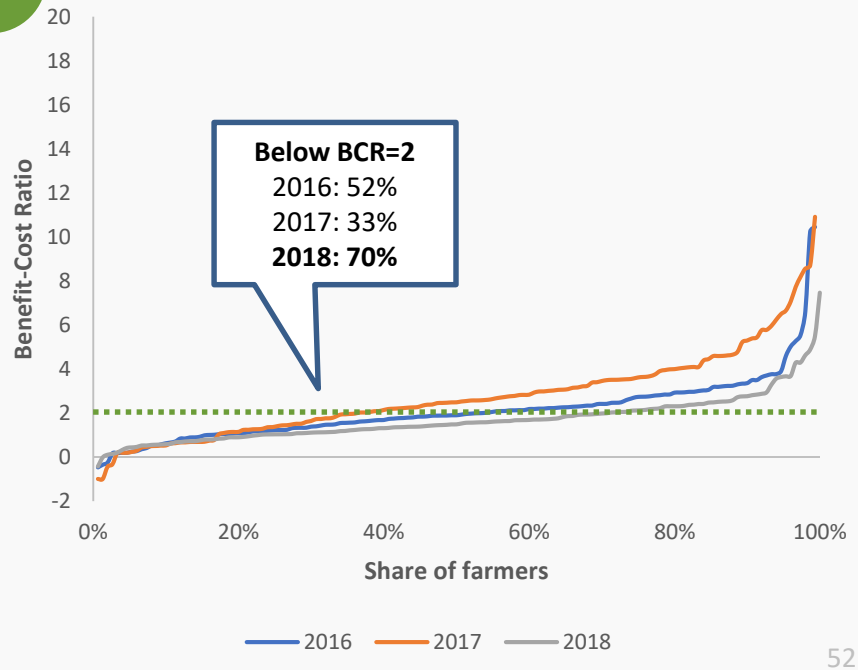


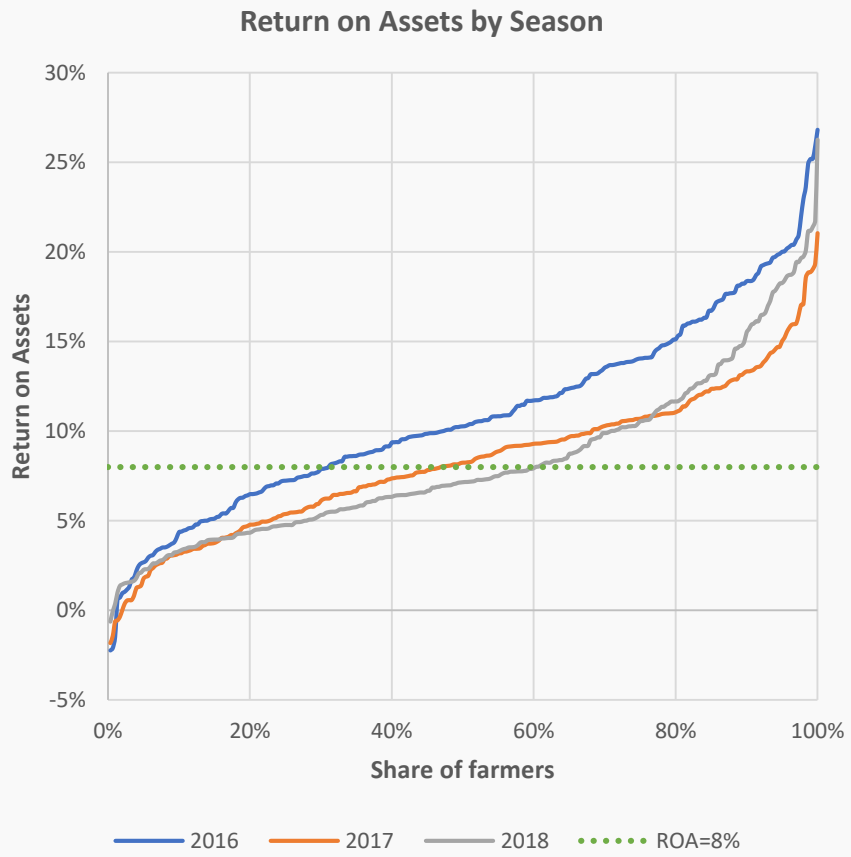
Fig. 2

Distribution of Benefit-Cost Ratio by Season, Dak Lak



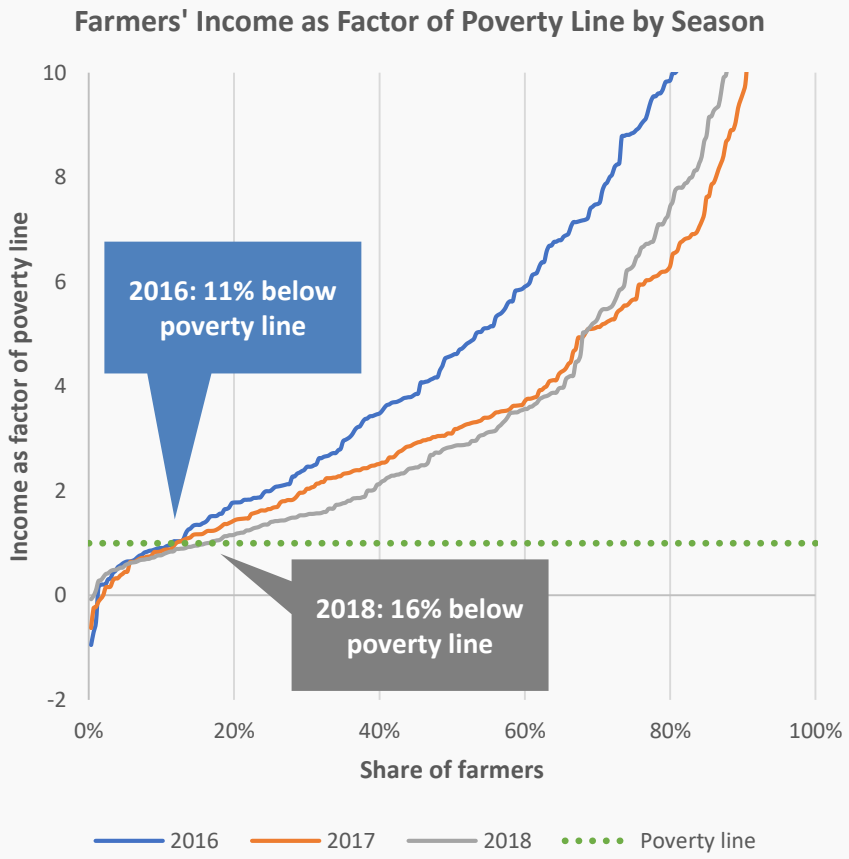
Farm economics: The average rate of return on assets is down from 10.9% to 8.2%. Farmers with poor returns (<8%) used to produce just 16% of the total supply but this is now 37%

- The Return on Assets (RoA) is calculated by dividing the profit margin(revenues minus costs) by the total value of coffee production assets of a farmer.
- We have valued land at an estimated current market value of 900 million VND/ha and added that to the production assets data from the FFB. This gives farmers an average asset value of 1.93 billion VND, of which 2.1% is in the form of machinery and equipment.
- Further assuming a minimum Return on Assets of 8% for coffee to remain economically viable, shows that 31% of farmers were below this threshold in 2016, whereas in 2018 this share increased to just over 60%. As with the BCR, a seasonal snap-shot is insufficient and longer term data is required to provide more insight.
- As part of the economic viability discussion, gaining more insight into farm financial ratios such as these and how to improve them will be useful.
- Also, we think it might be prudent for the project implementers to actively seek out some of the farmers who are in the 10% or so with lowest ROAs and speak to them about how they see their future in coffee and what their short, mid and long-term plans are for their farms. This may help to validate our, admittedly arbitrary, assumption that 8% is a suitable threshold.



Farm economics: The share of farmers below the poverty line has increased by 5 points to 16%

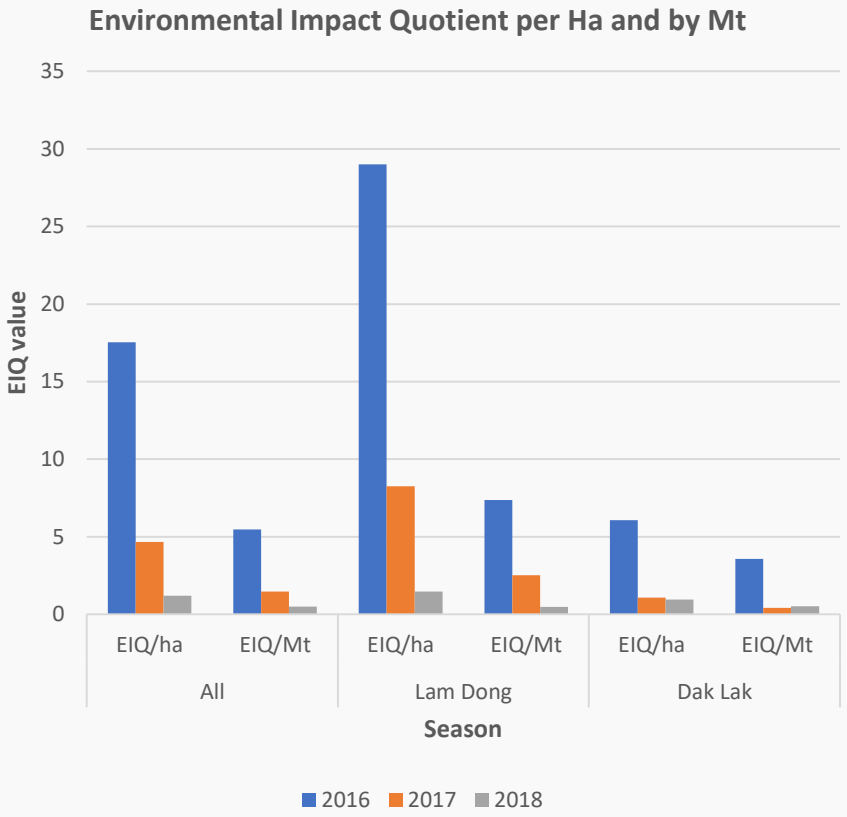
- With the lower coffee prices we think it prudent to analyse where farmers stand relative to the World Bank's 1.90 $/day poverty threshold. The coffee crisis of 2001 pushed many coffee farmers into poverty
- To analyse where the FFB farmers are compared to this threshold we use the international poverty line definition of 1.90 $/person/day, converted to Local Currency Units (VND) using the private consumption PPP factor from the 2011 ICP round, extrapolated to 2016, 2017 and 2018 using the domestic Consumer Price Index to correct for inflation. This results in a poverty threshold of 21,803 VND/person/day in 2016, 22,571VND in 2017 and 23,006 VND in 2018.
- For each farmer, we calculate a personal poverty line income by multiplying the number of household members who rely on the income from coffee for their livelihood with the number of days in a year and the PPP adjusted 1.90 $/person/day.
- We then divide the farmer's income by his poverty line income. If the resulting value is 1, a farmer is on the poverty line. A value below 1 means a farmers is under the poverty line.



Results
Environmental performance

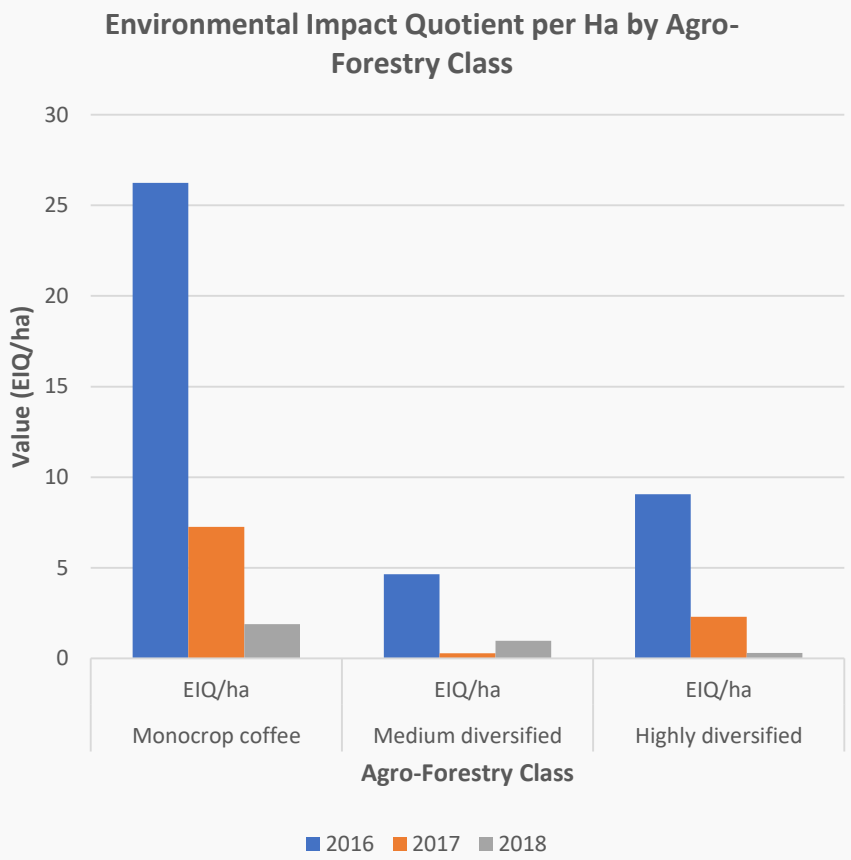
Environmental performance: The environmental impact quotient per ha has dropped significantly from 17.5 to 1.2, indicating sharply reduced use of the most hazardous biocides

- The EIQ is a compound index value that aims to give an index figure for the toxicity of a pestcide. The FFB software calculates EIQ values using the Cornell University's EIQ database and the volumes and active ingredients of the pesticides used by farmers.
- The average EIQ for all farmers, including those that do not spray, is 17.5 per ha.
- The differences in EIQ per ha between the provinces were significant in 2016, with farmers in Lam Dong having a much higher EIQ than those in Dak Lak, but this is no longer the case in 2018.
- In the absence of benchmark EIQ data for coffee production we decided back in 2016 to set a target of achieving an average EIQ per ha of 29. This value represented the median EIQ value of all the original 900 FFB farmers in the ISLA programme in that year. Our recommendation was to target farmers with high EIQ values and offer them non- or lower toxic alternatives.
- This appears to have worked, EIQ values are now extremely low and while some use of Highly Hazardous Pesticides continues to take place, this is confined to a small minority of farmers.



Environmental performance: Toxic loading, as measured by the EIQ rating, has reduced significantly, down to a level where we believe it is no longer a concern

- Intersting to note is that the EIQ in Highly Diversified farming systems in Dak Lak (that often grow pepper) is so much lower than that of even the Monocrop coffee farmers in Lam Dong, while pepper is known to require significant fungicide applications.
- While local agro-ecological conditions differ between the provinces, Highly Diversified farmers in Dak Lak show that it is possible to grow pepper and still have a relatively low EIQ.
- Across all groups reductions are significant. The Medium Diversified farms show the smallest reduction, but even there this still amounts to 79% lower EIQ ratings. Farmers in the Monocrop coffee group reduced their EIQ by 92%, while the Highly Diversified farms posted a 96% decrease.
- If we take the EIQ as a metric for toxic loading, the reduction of which is one of the ISLA programme's targets, then within the projects that keep FFB records we can conclude this is achieved.



Environmental performance: Lower EIQs do not say much about the use of specific chemicals that may, rightly or wrongly, receive much attention

- The court cases in the USA against Bayer for the supposed relation between glyphosate use and occurrence of cancer has pushed glyphosate to the forefront in many agricultural sectors, including coffee.
- To help stakeholders understand the scope of glyphosate use in coffee production in Vietnam, we have run separate analyses for this.
- In addition to drawing on FFB data from the ISLA programme, we also used FFB data from earlier projects that we have access to that cover the period 2002 to 2009.
- Data from the 2002 to 2004 period was ultimately not used due to a very small N of just 50 to 75 farmers, but the remainder had a sufficiently large sample size to be useful.
- While we do not claim that this data is fully representative for the whole sector, it does give more insight into glyphosate use than most stakeholders would have without it.
- In the next pages we dive deeper into glyphosate use and alternative weed control strategies that farmers can, or are already deploying.

Environmental performance: Glyphosate use may be on a downward trend and appears increasingly concentrated among a few heavy users, as witnessed by the increasing standard deviation of average use.

- Average Glyphosate use amounts to 0.003 liters of active ingredient per Mt coffee in 2018 (Fig 1), a sharp reduction from previous years and a 61% drop compared to 2017. We can observe that the standard deviation is increasing, which points to a smaller share of farmers being responsible for a larger share of the total usage.
- Of the 7 years of data for which we can calculate the change on the previous year, we find 5 years with a reduction in usage and just 2 with an increase (Fig 2).
- When evaluating glyphosate use for the whole population, it only makes sense to look at averages as less than 50% of farmers in the collective FFB files going back to 2002 use Glyphosate. (first 3 years not shown here; the median is therefore zero).

Fig. 1

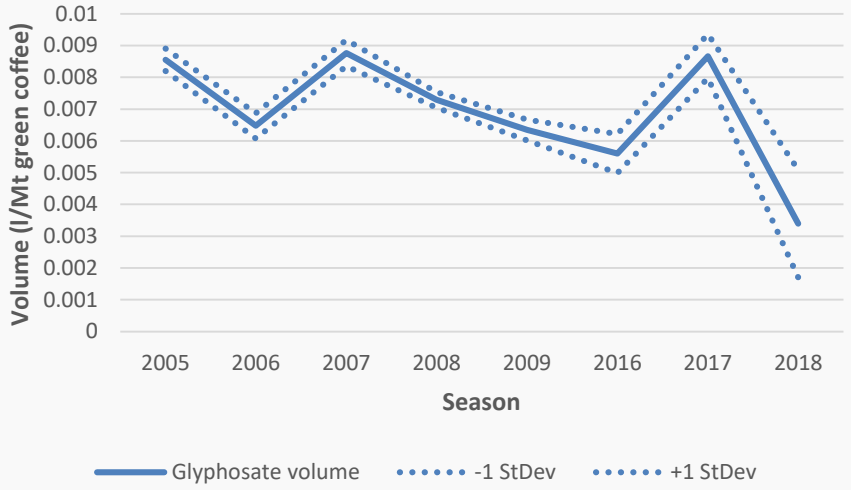
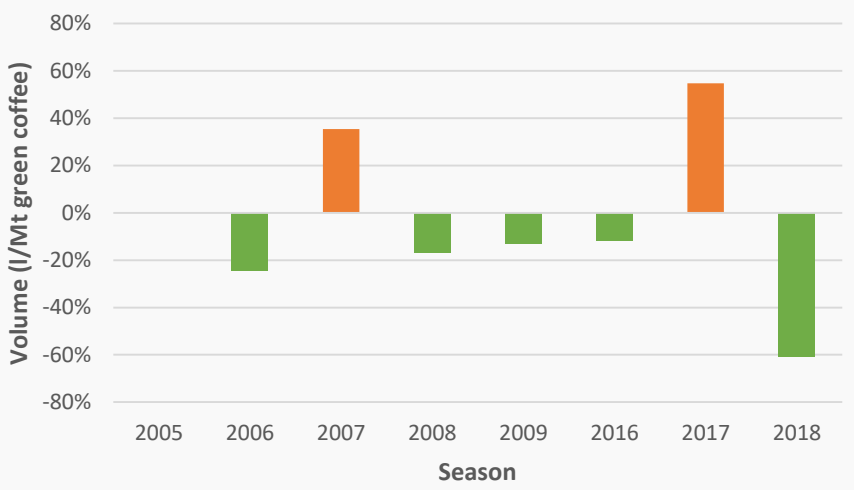
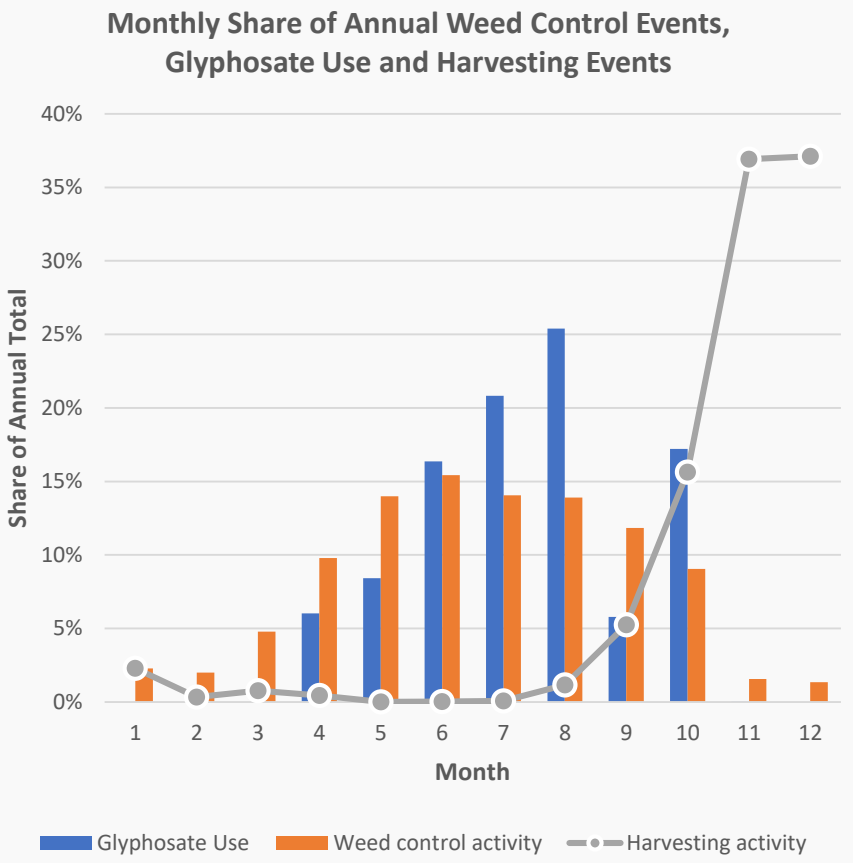


Fig. 2

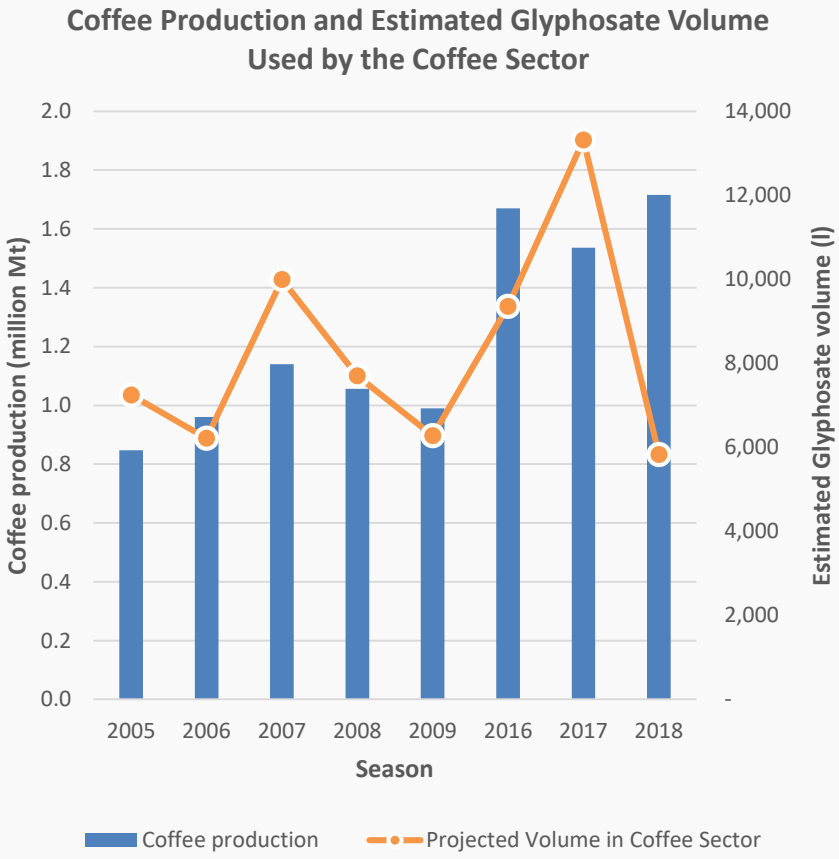


Environmental performance: Glyphosate use tends to peak in July/August, with a final round of application in October to clean the field before the harvest begins.

- Weed control takes place predominantly from March/April to October. Typically, farmers conduct 2 to 3 weeding cycles per season.
- Glyphosate use peaks in the period June to August and October, in those months 16,%, 21%, 24% % and 17% of the average annual volume is applied to the field. The latter application takes place just before the start of the harvest, which reaches peak levels in the months of November and December.
- The October application is done to clean the field from weeds before the harvest starts.
- We have to keep this in perspective though: **less than 5% of the weed control events involve the use of glyphosate**, much of it used to be done manually, and in more recent years increasingly involves the use of brush cutters. Using these is also part of the sustainable production techniques that many stakeholders are promoting.



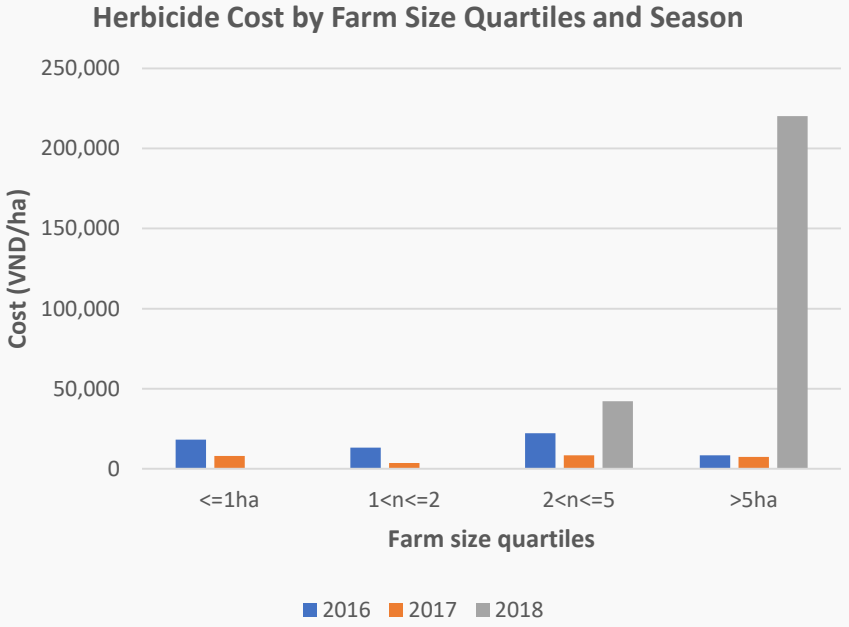
Environmental performance: We estimate that the coffee sector uses between 5,800 and 13,300 liters of glyphosate per year. Reportedly Vietnam imported 30,000 Mt of glyphosate in 2018, half of which is used in agriculture.

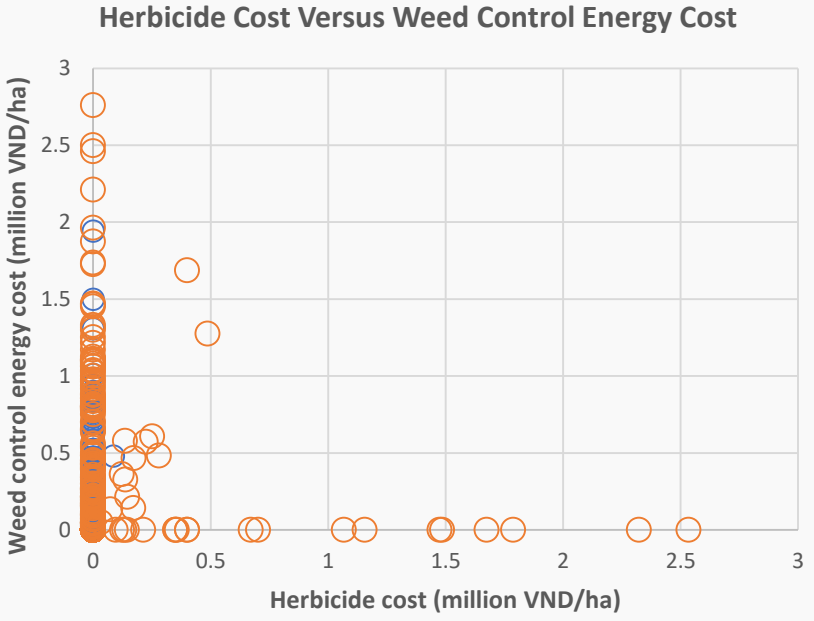


- Vietnam imported 65.68 million USD worth of glyphosate products in 2015 (the only year for which we could find such data), which makes it the single most important herbicide[7].
- According to the same publication, 28.49 Mt of glyphosate was imported, but this would imply a cost of 2.3 million USD/Mt, which is about a factor 1000 higher than normal. So more likely is that imports were 28,490 Mt. This however would imply that Vietnam uses about 4% of global production.
- If we compare the value of what coffee farmers spent in 2016 on glyphosate and compare this with the 2015 import value, then coffee used an estimated 2.6% of glyphosate. We would expect this to be higher, although another article said just half of the glyphosate imported is used in agriculture, in which case coffee would be responsible for 5.2% of the agricultural glyphosate utilisation in Vietnam.

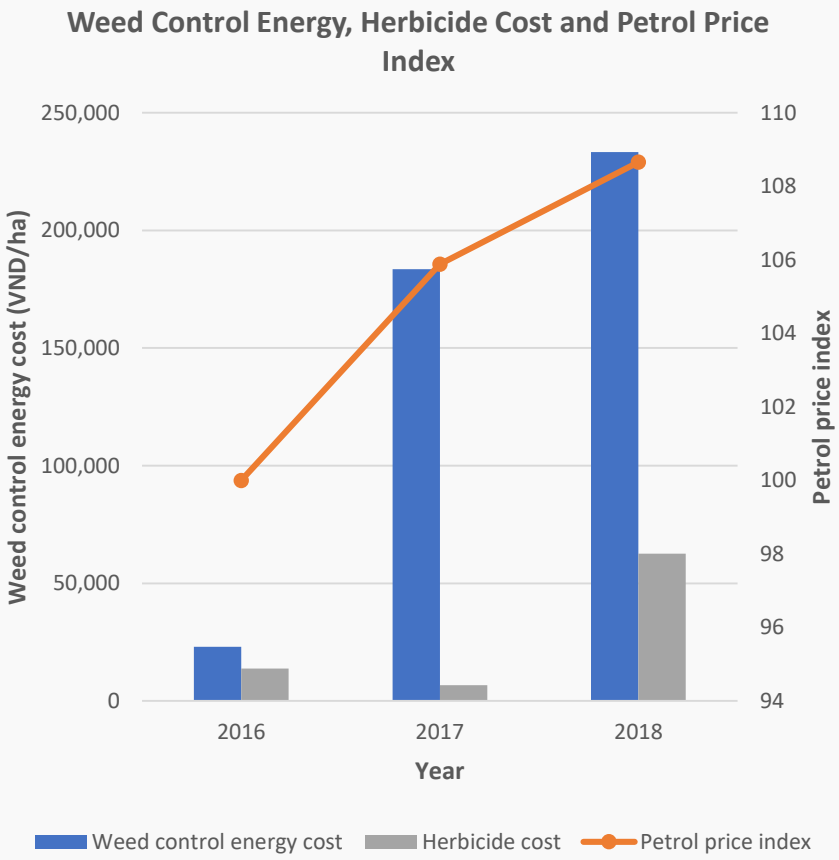
Environmental performance: Glyphosate usage is already low and brush cutters are a viable and much-favoured alternative that most farmers resort to.

- Up until recently, smaller farms, which tend to be managed more intensively, showed higher average herbicide expenditures per ha, but in 2018 this has shifted with the larger farms of 5ha or more responsible for 83% of said expenditure.
- All farmers are affected by low prices, but farms over 2ha in size arguably more so as they rely to greater extend on (costly) hired labour to manage their operations. It makes sense therefore that these farmers increasingly opted for herbicides to economise on labour for weed control in the current low price market.
- Still, they are a minority. The figure to the right shows herbicide cost versus equipment energy cost for weed control. Farmers who spend on energy for weeding, are typically using brush cutters. The choice tends to be a binary one, farmers who use brush cutters tend not to use herbicides and vice versa. Very few do both.





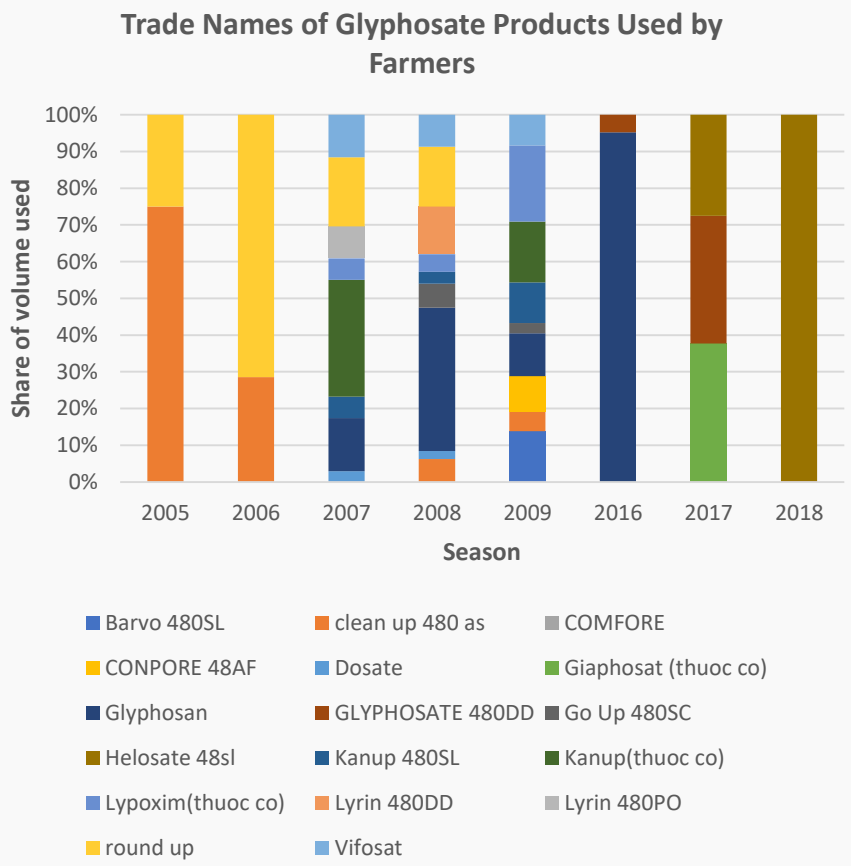
Environmental performance: Brush cutters are increasingly being used to control weeds and provide a viable, non-chemical alternative to glyphosate and herbicides in general.



- Herbicide cost was on a downward trajectory with 50% reduction from 2016 to 2017, but increased again in 2018, driven by increased use on the large farms.
- Still, the amount of money spent on energy (primarily petrol) for powering brush cutters has increased by a staggering factor 10. Over the same time, the petrol price index moved from 100 in 2016 to 109 in 2018, indicating that the higher energy expenditure signifies a change in weed management strategy.
- We have to keep in mind that these figures were obtained from projects with the express purpose of promoting a more sustainable production system. From this data we cannot conclude that this trend holds for the entire Vietnam coffee sector (although we are of the opinion that it probably does), but it does give a good idea of what can be achieved if an organisation would want to reduce the usage of herbicide in general and glyphosate in particular.

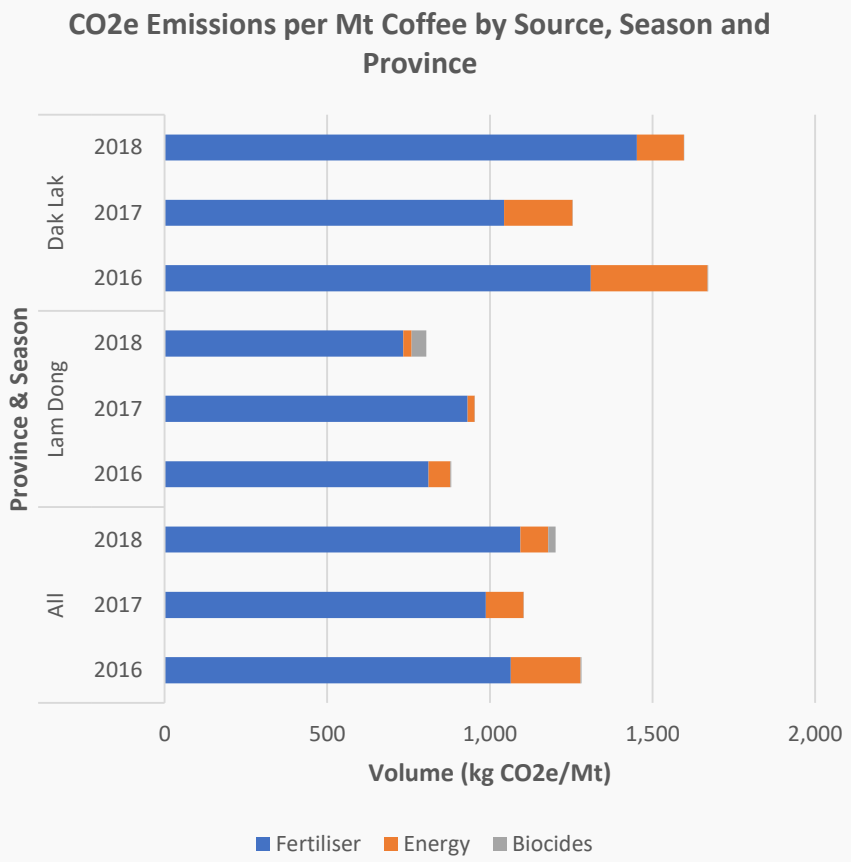
Environmental performance: Imports to Vietnam are mostly from China, there appears to be a high turnover of trade names and brands.

- The pesticide market in Vietnam appears to be quite dynamic. We observe new trade names popping up, be available for 2 to 3 years, before dropping of the radar again.
- Currently, Helosate 48SL is the most commonly used glyphosate product among coffee farmers in the FFB.
- According to Vietnam customs, nearly all Glyphosate products are imported from China.
- In reaction to the court cases that Bayer is facing in the USA on Glyphosate use and cancer, the Vietnam government recently announced a temporary import ban on Glyphosate products which at the time of writing was changed into what seems to be a permanent ban with a 1-year phasing out period.
- Existing in-country stocks can continue to be sold off, but we expect a sharp reduction of glyphosate use over the next 2 to 3 years.
- A previous ban by Vietnam on 2.4D and paraquat which took effect in early 2017 saw their use drop off once existing stocks had been sold off.



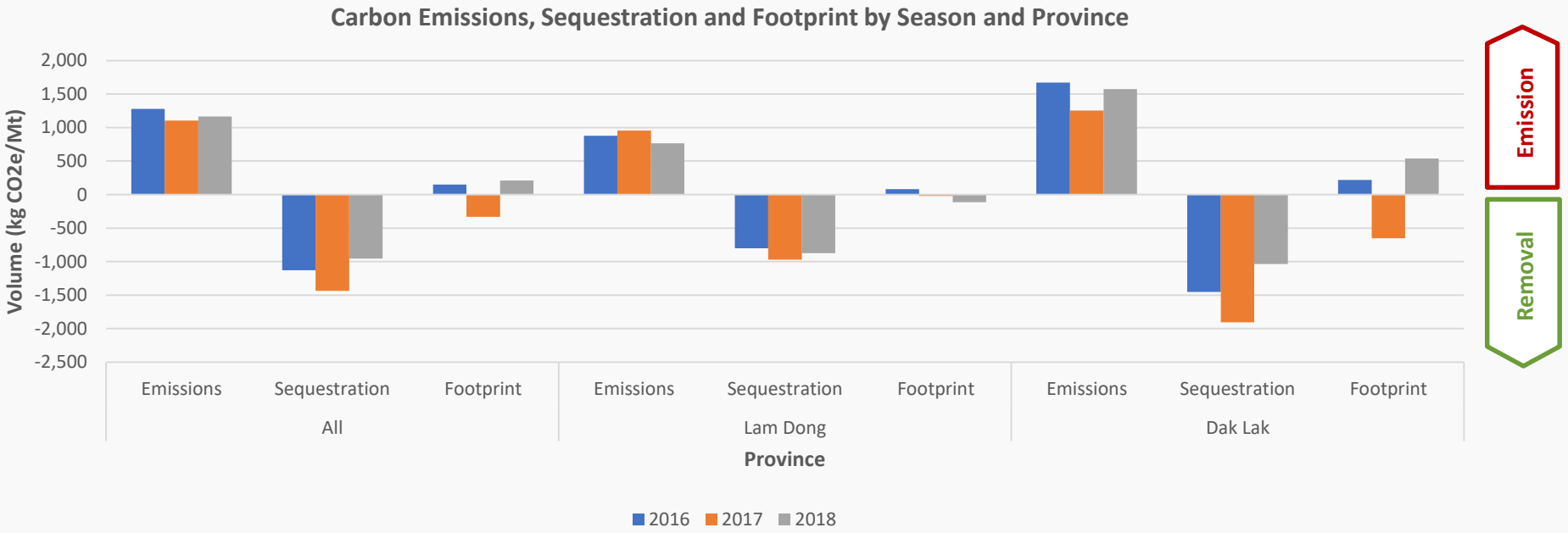
Environmental performance: The role of fertiliser management is critical to controlling emissions from coffee production

- The farms in the FFB sample have all been established more than 20 years ago. In line with the Product Category Rules for green coffee[8], emissions associated with taking land into cultivation are no longer included if the farm was taken into production more than 20 years ago.
- This means that emissions associated with fertiliser application are by far the most important source.
- Of the fertilisers that farmers use, those that contain nitrogen are the largest contributors to farm level emissions. We could see in the Farm management section that a significant share of farmers continue to over-apply nitrogen, indicating that there is further room for reducing emissions without endangering yield levels.
- We can also observe from this graph, that the dry year in 2016 is associated with higher emissions levels from energy for pumping irrigation water.



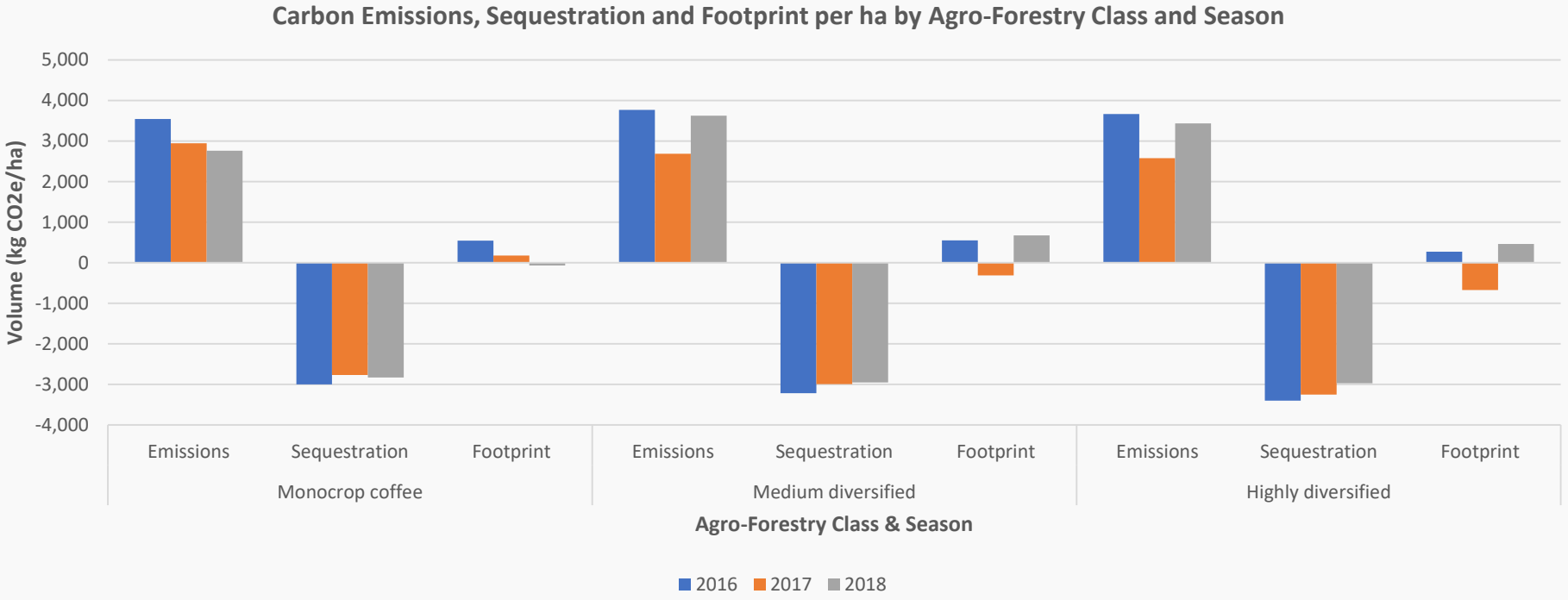
Environmental performance: Coffee can be a mitigating factor in climate change, removing more carbon from the air through biomass growth than it emits in production. Fertiliser and diversification are key factors in this.

- Once we factor in the rate of carbon sequestration on each farm, we find that coffee can be produced in a climate neutral manner, but the balance between being a net emitter of carbon or a farm that sequesters more is a precarious one.
- The jump in fertiliser application levels in Dak Lak that we observed in the Farm management section has pushed the average there from acting as net carbon sinks in 2017 to being net emitters again in 2018. This is exacerbated by a higher rate of stumping in Dak Lak in 2018.



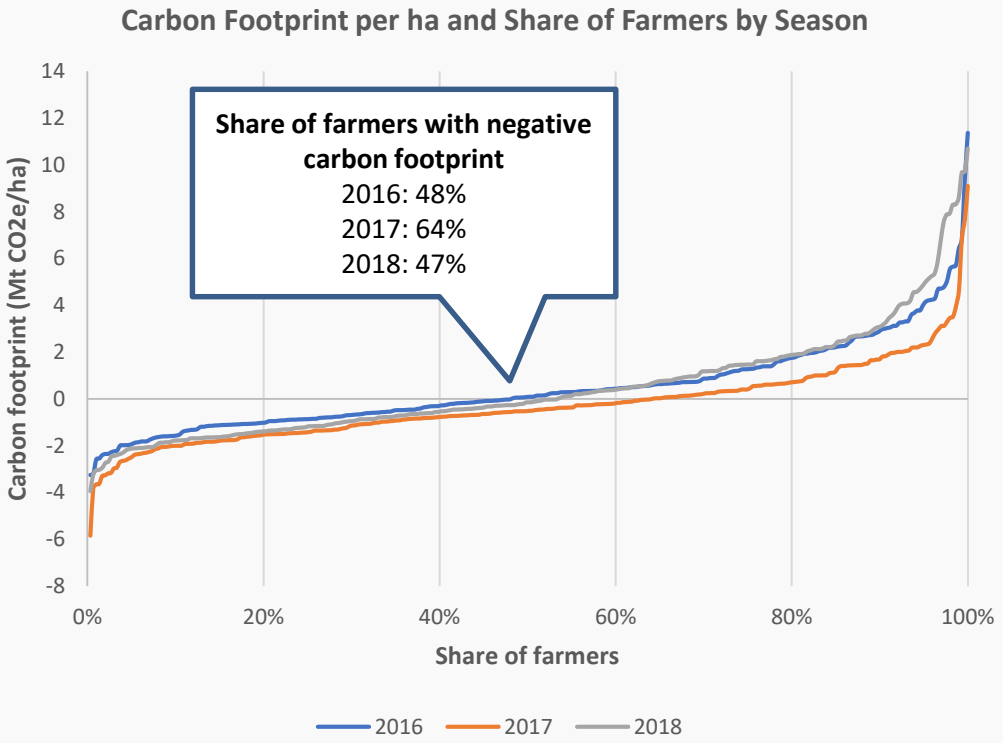
Environmental performance: In 2017 Highly Diversified farms had a significant negative carbon footprint per ha, but a shift in fertiliser management has pushed their average back in the group of carbon emitters

- Rates of sequestration are affected by farm management choices and farming systems. Annual additional sequestration of the highly diversified systems is not much greater than that of the other systems, but over time the annual differences add up to larger carbon stocks.
- Still, the role of fertiliser management remains critical. In 2018, part of the monocrop farmers were applying lower levels of fertiliser, while the highly diversified farmers applied more on average and this immediately impacts their respective carbon footprints.



Environmental performance: The farmers with a negative carbon footprint are also those who use nitrogen most sparingly. Their yields are not significantly different from those with higher footprints while their margins are better

- Roughly half of the farmers are acting as net carbon sinks. We find no significant difference in yield levels between farms that act as sinks or emitters of carbon, indicating that on average there is room to further fine-tune nitrogen applications to optimise emissions versus yields.
- The economic argument for this is also strong: profit margins among the more efficient nitrogen users are showing consistently higher profit margins per ha.



N applied (kg/ha)	Season		
Quintile by carbon footprint	2016	2017	2018
0%<x>=20%	236	158	183
20%<x<=40%	284	242	255
40%<x<=60%	376	308	343
60%<x<=80%	422	370	409
80%<x<=100%	592	504	430

Recommendations

Recommendations

- **FFB implementation:**
  - Overall we are satisfied with the quality of data provided by the famers. In the first year irrigation volume data was not yet very reliable, but the correlation between energy cost for pumping and reported irrigation volumes has improved significantly to a level where we are comfortable drawing inferences from it.
  - If possible, it would be desirable to add 60 or so farmers to the FFB who fall in the Medium or Highly diversified categories in Lam Dong province. This was also a recommendation in 2016 and for the upcoming 2019 and 2020 seasons we understand this will be done in Lam Dong.
  - Implementation of the FFB is relatively costly due to the high frequency of data collection. For the 2019 and 2020 seasons selected farmers will start using the FFB app for Android to record their data. We recommend to only do this with selected farmers who have already been keeping paper records for at least 1 season and have seen the personal and group reports they obtain.

- **Farm management:**
  - On the use of biocides banned by standards, significant improvement has been made. It is important to remain vigilant and with the recent ban on glyphosate we recommend the companies to communicate the prohibition on this herbicide to their farmers.
  - K applications appears to be too low, farmers on average remove nearly twice the K that they apply. Volcanic soils tend to be rich in K and contrary to N, K does not wash out easily. Farmers have been mining their soils probably ever since they planted their first coffee trees. This process can go on for some time as natural stocks of K can be high, but at some point this will become a limiting factor. In Dak Lak we already see this, and there increasing K applications is required. In Lam Dong, this may also already be the case. But there we have very few farmers with balanced K management. The limited number of such observations could be one reason that contrary to Dak Lak, K applications in Lam Dong do not show a positive correlation with yield. In Lam Dong we therefore recommend to run a number of on-farm trails (10 to 15) where optimal K application levels are applied to determine if and how this is affecting yield levels. Participating farms could be split in 2, with one half under normal nutrient management and the other with optimal K applications.

Recommendations

- **Farm management:**
  - In line with the above, we think that more or new training on how to determine nutrient requirements is needed. In the absence of soil tests, we advise to train farmers on how to determine the expected yield, prior to the first fertiliser application. A kg of fresh cherry contains about 0.5% N, 0.068% P and 0.6% K. With these values and the nutrient content of fertilisers the amount required can be calculated (with some additional N application to cover for N losses due to emissions and leaching into the ground water).
  - If soil tests are done, we advise to test out the recommendations on a small number of trees first and carefully evaluate the economic effects. In our experience not all soil laboratories provide good advice, often over-estimating how much nutrients need to be applied. An exciting development is that in Lam Dong all FFB farms will receive a soil scan using a hand-held device developed by AgroCares. This data and the recommendations provided will be integrated into next year's analysis so we can compare recommendations with farmers' actuals and estimate the economic effects of applying the recommendations.

- **Farm economics:**
  - While many farmers earn good or acceptable returns, both from a BCR and RoA perspective, there is also a significant share that do not and this is reaching worrying proportions in Dak Lak. We recommend the companies to seek these farmers out and try to determine what is driving their low returns and how that affects their future plans for coffee and/or diversification. While farmers are unlikely to stop production in any given year, a continued low return may change that. For coffee trading companies we feel it is important to understand such mechanisms.

- **Environmental performance:**
  - Continued monitoring of glyphosate use is recommended given the sudden urge with which some coffee importers are treating this topic. Continued promotion of non-herbicidal weed control strategies is advisable. Also, now that glyphosate will be banned in Vietnam, the use of glyphosate will automatically be banned by standards and its use by farmers should be part of sustainability audits in the next season. This gives certificate holders another reason to be vigilant on its use.

AGRI LOGIC

About Agri-Logic

Agri-Logic – management, consultancy and research - operates where agricultural production, development, international trade and consumer markets intersect. We combine a thorough understanding of farm level reality and commodity trade with scientific research skills and a track record in sustainability strategy design and implementation, to help clients deal with sustainability challenges and market requirements.

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