# HARVESTING TECHNICAL NOTE

HTN12-04
2019

# A Survey of Ground-based Harvesting Systems in New Zealand

## Summary

A comprehensive survey was completed to measure the total number of ground-based systems currently working in New Zealand, as well as provide some key characteristics for those crews. A total of 385 crews were identified in the survey, however it is recognised that there will be omissions due to crews not identified, possibly up to a further 10% comprising mainly independent woodlot crews. That means, the actual total number of crews is expected to be between 385 and 425. Additional details were obtained that included crew size, number of workers and machines, as well as daily production target. The dominant primary extraction method for 63% of the crews was grapple skidding, with a further 16% using forwarders. Average crew size was 5.4 (range 3-9), indicating a total of approximately 2,150 forest workers directly employed in ground-based harvesting crews. Crews operated 4.2 machines on average (range 2-7), resulting in a total of 1,680 machines currently in use. Production targets varied from 85 to 700 tonnes per day, with an average of 291 t/day.

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## INTRODUCTION

Harvesting systems can readily be divided into ground-based and cable yarding systems. Harvesting crews are an important and integral part of the New Zealand forest industry, but no national database exists that details the number of crews in operation, and the types of machines operating.

Despite the fact that there is no formal industry or government registry for forestry equipment or harvesting crews in New Zealand, there have been a number of surveys undertaken of the logging industry over the years (Fraser *et al.* 1976, Liley 1985, Lyon & Raymond 1993, Finnegan & Faircloth 2002).

With the focus on steep slope harvesting within the FFR (now FGR) Steepland Harvesting programme (from July 2010 – Sep 2017), a survey of rigging configurations in cable logging was undertaken in 2011 (Harrill and Visser 2011), followed by a survey of cable yarders in 2012 reporting the number of machines and the makes and models of machines on which those systems were being used (Visser 2013).

A combined yarder and rigging survey was completed in 2018 (Harrill and Visser 2018) that reflected on the changes, especially around mechanisation, that had occurred over that time frame. For example, the number of NZ cable logging systems estimated in 2018 was 318 (Harrill & Visser 2018), and the authors found little growth in total numbers of crews in the 6 years between surveys; which was attributed to much higher levels of mechanisation, increasing crew productivity.

This report details the survey of ground-based harvesting systems present in New Zealand in 2018 as a base for comparison against changes that may occur over the next decade as a result of further innovations in the forest industry.

The last similar surveys of ground-based harvesting crews were completed in 1985 (Liley 1985) and 1991 (Lyon and Raymond 1993) and included the number of New Zealand logging crews and a breakdown by region, machines used and daily production. Prior to those surveys, Fraser and others (1976) reported on a comprehensive survey carried out for the year ending March 1974.

### *1974 Survey*

The total harvest in 1974 was 8.6 million $m^3$ – of which 0.9 million $m^3$ was still from harvesting native timber. This was a year-on-year increase in harvest volume of 5% over the previous ten years showing strong growth in the industry and harvesting capacity. Through an iterative approach of mail survey, followed up by company visits, harvesting systems information was captured that represented about 78% of the total



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annual production at the time. As a median value, there were 39 crews that produced between 36,000 and 54,000 $m^3$ per year; which is approximately 165 to 245 $m^3$ per day (assuming 220 work days per year).

In terms of extraction machines, of the 441 identified, most common was the tracked skidder with 49% of the total. Of the other extraction methods reported, 35% were skidders and only 12 were cable yarders (and 4% 'other'). The report indicated that approximately 2,770 workers were directly employed in logging crews – although a Forest Service estimate at the time indicated 3,140 people. In terms of tasks for those surveys, the majority of workers were 'felling and trimming' at 37% of the total. In comparison, only 28% were 'machine operators'. Overall productivity per worker hour was 2.2 $m^3$/hr in exotic clear-felling, down to 1.3 $m^3$/hr for Indigenous and 1.2 $m^3$/hr for exotic thinning.

***1985 Survey***

Total number of logging operations identified by Liley was 578, with well over a third (229) in the Central North Island, then 61 in Hamilton and 50 in Wellington. The 'regions' listed all had between 28 and 42 crews; being Northland (33), Napier/Gisborne (41), Wanganui (42), Nelson (29), Westland (32), Canterbury (33) and Southland (28).

The report also produced the following graphic (Figure 1) that shows the breakdown of equipment being used. While cable (and grapple) skidders were the dominant extraction option (315), there were also many tracker skidders (dozers with arch). Considering there were 578 crews, only 258 loaders (both knuckle-boom and front-end) were identified. The report suggested only 82 yarders ('haulers') were operating, 38 of which were independent spar towers; or approximately a third of what we have today. One very visual indication of how far we have come is that an excavator based harvester was grouped together with forwarders and horses into 'Other' category – with only 27 units.

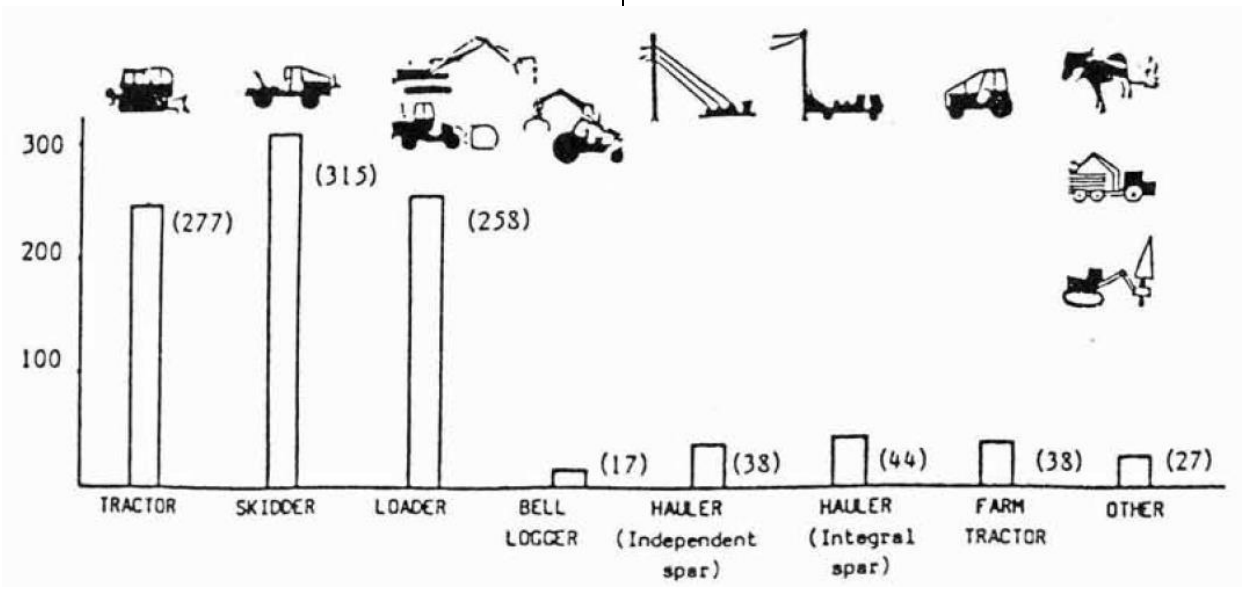


***Figure 1: Total number of machines used by New Zealand logging crews, by type (Liley 1985).***


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Another interesting statistic is to review the reported productivity of the logging crews. Figure 2 shows how mechanisation was being very much driven by the Central North Island, with distinctly different productivity expectations compared to the rest of the country. A typical target was two or more truckloads per day, with approximately 55 crews already producing more than 8 truckloads per day.

These higher production crews were working in: large piece size, first rotation stands on pumice soils, with relatively few log sorts to congest landings and good access to off-highway road networks (*pers. com. Bill Liley*). Conversely, the most common 'target' for the rest of NZ was still just one truckload per day (45%), or just two truckloads (25%). So only about 30% of crews produced three or more truckloads per day. An overall weighted average would be 3.4 truckloads, or 85 $m^3$ per day.

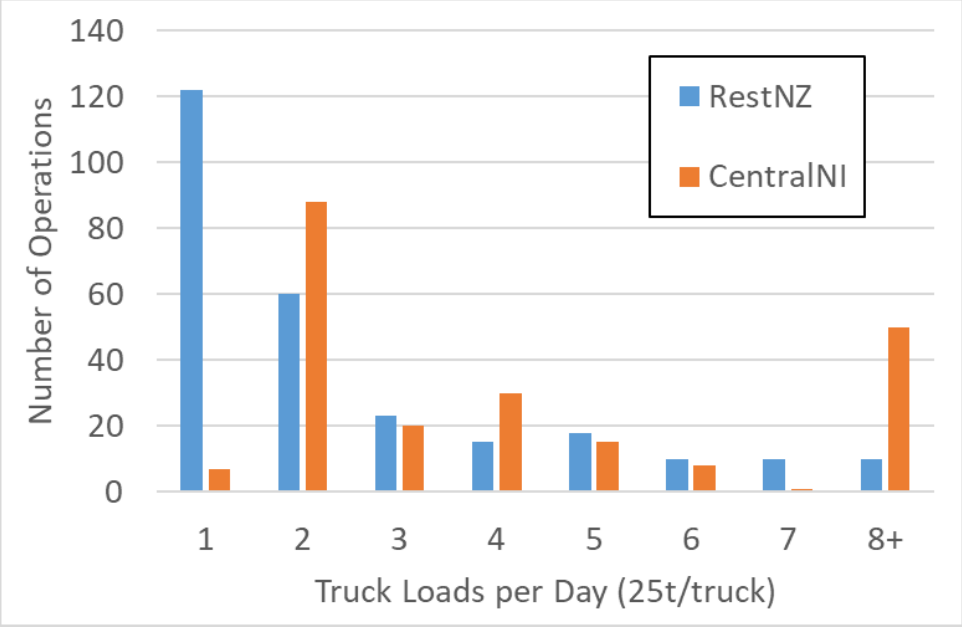


***Figure 2: Daily production (in truckloads) from New Zealand logging crews (Ref: Liley 1985).***

### *1991 Survey*

Lyon and Raymond (1991) reported 500 logging crews on a Logging Industry Research Organisation (LIRO) mailing list; of which 283 responded to their survey (accounting for 60% of total volume harvested at that time). The average crew size was 6.7 workers in clearfell crews, and 4.7 in thinning. The authors estimated a total of 1,430 people employed, and 654 machines used, or 2.3 machines per crew. In terms of methods and machinery 95% utilised motor-manual felling, 59% used skidders, 30% used tractors and only two forwarders were identified. Average daily production was 187 $m^3$/day (or 3.55 $m^3$/worker-hour). At the time only 11% of crews used haulers (yarders); which equated to a total of 47 machines in the study.

Crew production, reported in $m^3$ per year, averaged 43,950 $m^3$ p.a., or 187 $m^3$/day for clearfell crews. For thinnings operations, the average annual production was 15,900$m^3$ (or 68$m^3$/day).

Figure 3, shows that the majority of thinning crews were producing between 10,000 and 20,000 $m^3$ per year. Clearfell crews had a much larger range, from 10,000 to over 80,000 $m^3$ per year. These data represented an average


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increase of 16-18% in annual production per crew from that reported from the 1986/87 Logging Workforce Survey (Gaskin *et al.* 1987). While mechanisation had commenced by the mid-1970s in the central North Island, the main gains were attributed to the transition of company crews to independent contractors and the absence of production quotas at the time of the survey.

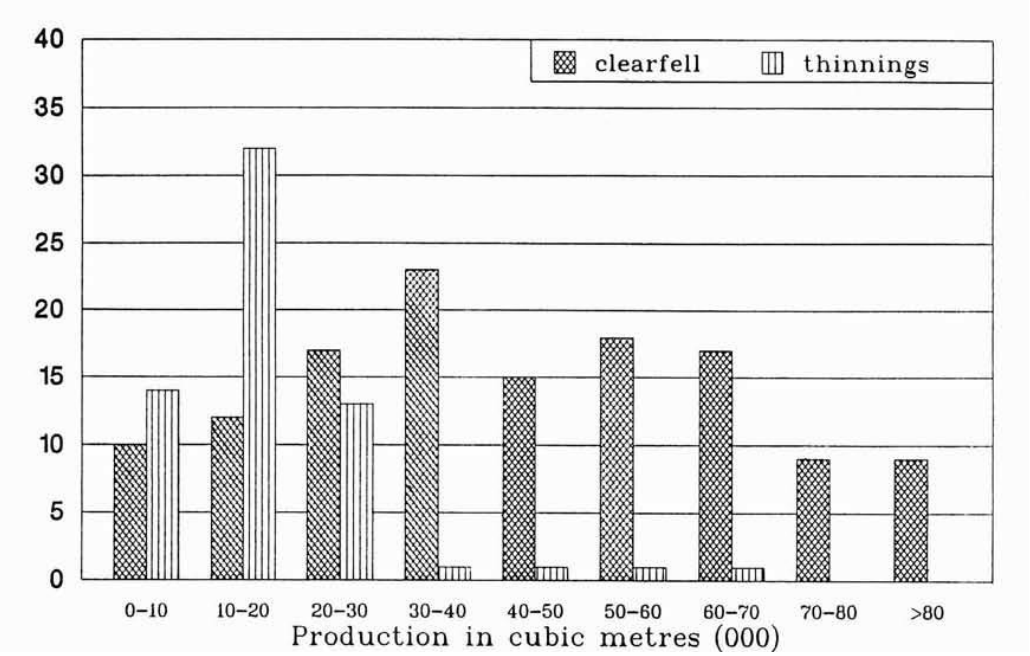


***Figure 3: Annual production for clearfell and thinning crews in 1991 (Lyon & Raymond 1993).***

***Other Surveys***

Other previous studies from the NZ Forest Service/FRI/LIRA and LIRO, mainly focussed on logging workforce characteristics such as employee training, and demographics. Wells (1980) suggested that the industry targeted a high rate of productivity to keep costs low and therefore it was necessary to focus on retaining labour. The author suggested employees that were poorly trained had the highest risk of turnover. The study also suggested given 2,600 workers in 1976/1981, the workforce would increase to 11,500 in 2011 based on increased harvest volume expected in the future. However, Smith and Wilson (1983) found turnover rates in logging decreased rapidly between 1960 and the mid-1970s with higher levels of professionalism.

In order to put the size and scale of the New Zealand logging industry into context, other countries and regions were identified which use similar systems and machinery. One example is the Pacific North-west (PNW) and particularly the state of Oregon. While the authors were not able to identify similar surveys in the PNW with as much detail as the New Zealand surveys, some general information about the size of the workforce was obtained. The total annual harvested volume in 2018 in Oregon was approximately 9 million $m^3$; of which 78% was harvested from privately owned land which totals just over 4 million hectares (OFRI 2019). Of interest to New Zealand is that Oregon also has a relatively large farm forest/woodlot estate consisting of smaller owners. Small private land owners own nearly 1.5 million hectares of forest in Oregon and harvest 12% of the annual harvest.

Data from 2003 suggested that there were more than 900 logging firms operating in Oregon, but had decreased from almost 1,300 in 1994 (Garland 2005). The logging workforce in Oregon has been declining for over a decade, and was



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estimated to have decreased 50% in the period from 2000 to 2014; heavily influenced by the global financial crisis (Garland 2014). Recent employment data from 2017 suggests that the number of people employed in logging crews in Oregon was approximately 7,000 (OFRI 2019).

## METHOD

A preliminary list of contractors was made by extracting information from the FGR Benchmarking database (Visser, 2019), as well as the New Zealand Yellow Pages. However, most data was obtained by contacting New Zealand forest management companies directly and asking them to submit information about their harvesting crews, as well as other known crews in the regions (on the basis this information would only be used for research purposes). Smaller independent companies and consultancies were then identified and typically followed up with both an email and phone call. While most companies volunteered information, some companies only indicated total number of crews and kept contractor names and other details confidential. A few companies did not supply information as they did not want their crews to be recorded in the survey.

Once the initial data was entered, company representatives were provided the preliminary data, with the opportunity to augment the data with crews not yet identified. To complete the survey, a check was made by sending the database to the FGR Technical Steering Team (TST) members to identify possible errors, either in duplicate records (such as the crew using different names), or crews that had been missed. The error rate, estimated by the TST was less than 10%.

Another cross-check was completed using the number of identified crews, their average daily target, and using 200 production days/year, calculating the annual harvesting volume for the year. This equated to 21.1 million $m^3$ for the year, which, when added to approximately 8 to 9 million $m^3$ from the 318 cable logging systems identified in the 2018 survey (Visser 2018), compared closely to the annual harvest volume of 30 million $m^3$ harvested in the year to 31 March 2017 (NZFOA 2018).

One known bias in the survey is that it contains detailed information for harvesting crews working for the larger forest management companies, rather than the smaller independent logging contractors working in small forests and farm woodlots. As such, the authors recognise there is over-reporting in categories such as daily production. For example, many independent smaller crews do not work to a production target, and generally have fewer number of machines on site. There is no easy way to determine the scale of this bias and as such, numbers are reported based on the data received. Therefore this is not a full census of the logging industry.

## RESULTS

***Number of harvesting crews***

The survey identified a total of 385 ground-based harvesting crews, of which 242 operate in the North Island, and 143 in the South Island. In a final check on accuracy using TST members, the accuracy was within 5%; that is, only some additional crews were identified and very few deleted as duplicates. Given the stated level of accuracy of up to 10% of crews missed in the survey, the final estimate is between 385 and 425 crews.

From the 2018 cable yarder survey, 314 cable logging crews were identified (Harrill & Visser 2018). Therefore an estimated total of 700 to 750 logging crews are believed to be operating in the country as of 2019. Of interest is that this total number is only about 22% higher than those reported for the 1985 survey, and yet total annual harvest volume has increased three-fold in that time. It shows clearly the increased efficiency that has been achieved over the last three decades.

Many crews operate between regions, and companies that provided data also operated estates over several regions, so only an approximate regional breakdown is provided (Table 1).


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***Table 1: Approximate regional spread of ground-based crews***

| Region | No. of Crews |
|---|---|
| Northland | 42 |
| Central North Island | 66 |
| East Coast/Hawkes Bay | 53 |
| Southern North Island | 57 |
| Other NI | 24 |
| Nelson/Marlborough | 30 |
| Canterbury | 38 |
| West Coast | 8 |
| Otago | 29 |
| Southland | 38 |
| TOTAL | 385 |

The Central North Island had the highest number of crews with 66. The combined Nelson/Marlborough region only had 30 ground-based crews, evidence that this region is dominated by cable logging systems. There were 24 crews in the North Island not attributed to a specific region.

### *Daily Production*

Daily production target was provided either by forestry companies or the contractors for 212 crews. The average daily target was 291 $m^3$. There were 17 crews that had targets greater than 600 $m^3$/day, with all but one being highly mechanised grapple skidder crews in the Central North Island. Conversely, there were 25 crews which had targets of 100$m^3$/day or less. However, there was a large variation, and the production target information was mainly sourced from larger companies. If the crews that identified themselves in this survey as working in woodlots, were considered alone, the average daily target was 185 $m^3$.

Fraser *et al.* (1976) calculated an average worker productivity in 1974 of 2.3 $m^3$/worker-hour, which increased to 3.5 $m^3$/worker-hour in 1991 (Lyons and Raymond 1993). Using similar assumptions of an 8.5-hour work day, the 2019 production average of 291 $m^3$/day with an average of 5.4 workers per crew equates to 6.3 $m^3$/worker-hour. This shows a clear trend of increasing production efficiency, assisted no doubt through improved harvesting systems, better quality more uniform forest stands, more mechanisation and an increase in the overall level of training and professionalism in harvesting crews.

### *Felling and Processing*

Information was provided for 336 crews regarding their primary felling and processing systems. Results indicate that 68% of ground-based operations used mechanised felling, with the balance (32%) using motor-manual as their preferred methods. This value is somewhat low compared to the current corresponding value from the FGR Benchmarking database, which was 80% in 2018 (Visser, 2019). However, the Benchmarking database obtains data from large corporate forestry companies, not farm forests and woodlots. This demonstrates that in general the harvesting crews working in smaller forests are less mechanised.

In comparison to 1985, only 5% of crews reported using mechanised felling. The FGR Benchmarking database reported 50% mechanisation in 2009, so there have been some very rapid changes.

For processing the survey indicated 82% of operations were mechanised, so 18% of crews are still using manual log making and chainsaws. Similarly to mechanised felling, this is slightly lower than reported in the FGR Benchmarking database, where for the last few years mechanised processing on the landing has been present in between 88 – 90% of ground-based harvesting crews (Visser, 2019).

### *Workers and Machines*

The number of workers and machines per crew was provided for 311 harvesting crews in this survey. The average number of workers was 5.4, with 4.2 machines per crew. This resulted in approximately 2,150 people working in ground-based harvesting crews, operating a total of 1,680 machines. The 5$^{th}$ and 95$^{th}$ percentile for workers per crew was 3 – 9, and 2 – 7 machines per crew.

In comparison, the Liley (1985) survey reported only 2.3 machines per crew, and the 1991 survey reported 6.7 workers per clearfell crew (Lyon and Raymond, 1993). While there are currently fewer



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workers per crew, compared to these earlier surveys twenty-five and more years ago, the New Zealand forest industry has almost doubled the number of machines per crew (from 2.3 in 1991 to 4.2 machines per crew today).

The total annual harvest volume in New Zealand is expected to continue to increase beyond 35 million $m^3$ per year from the mid-2020s (MPI 2016). In comparison the Oregon experience (Garland 2014) of either static, or even declining annual cut will result in fewer workers as the level of production per worker-hour continues to increase. On the other hand, the increasing harvest from woodlots could result in more crews required, but of smaller size, and lower production. As indicated by Garland (2005) approximately 75% of logging contractor firms in Oregon had four employees or less. Small crew size is partly due to the common practice of logging crews sub-contracting felling, but also woodlot crews tend to have fewer workers. In this study the crews identified as working in woodlots averaged 4.6 workers (compared to 5.4 as the overall average) operating 4.1 machines.

***Extraction Machines***

Overall the dominant extraction system used by the crews in the survey was Grapple Skidder (63%), which was also the system with the highest average daily production at 331$m^3$/day (Table 2). The table also provides a breakdown in average machine and labour characteristics per crew. Other machine types were Forwarder (16%), Shovel Logging (9%), Tractor / Arch (6%), and only 4% for Cable Skidder. As would be expected, Cable Skidder and Tractor Arch systems have the lowest daily production expectations (166 and 164 $m^3$/day respectively). Surprisingly, Shovel systems only averaged 190 $m^3$/day, whereby in comparison to North America Shovel systems often complete with Grapple Skidders for highest levels of production.

***Winch-Assist***

Information was provided for 287 crews regarding winch-assist. A total of 55 ground-based crews had access to a winch-assist machine, which is approximately 20%. This is a strong indication that many ground-based crews are working in harvest areas with steep slopes where such assistance to the feller buncher is beneficial.

Overall, crews with winch-assist operated on higher daily production targets (295 vs 274 $m^3$/day targets). However, this difference became much more pronounced when focussing outside the Central North Island crews, which were producing more than 700 $m^3$/day. In this case the crews utilising winch-assist had an average target of 285 $m^3$/day, compared to 246 $m^3$/day for those crews without winch-assist.

***Table 2: Average values for daily production, number of workers and machines by extraction system, for ground-based crews in New Zealand.***

| | Grapple Skidder | Forwarder | Shovel | Tractor Arch | Cable Skidder |
|---|---|---|---|---|---|
| **Production ($m^3$/day)** | **331** | **233** | **190** | **166** | **164** |
| **Machines (#)** | **4.6** | **4.1** | **2.6** | **3.3** | **3.1** |
| **Workers (#)** | **5.6** | **4.2** | **3.8** | **5.8** | **4.4** |


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## CONCLUSION

A survey of ground-based harvesting systems was completed, which is the first comprehensive update since 1991. It shows not only the total number of crews, but also crew size in terms of numbers of workers and machines, as well as production targets. By comparing to previous surveys carried out in 1974, 1985 and 1991, a clear increase in productivity per worker is evident. So although total annual harvest volume has been increasing steadily over the last 35 years, the actual number of harvesting crews has not increased as previously forecast.

## AKNOWLEDGEMENTS

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