A Case Study on Rotational Grazing and Riparian Zone Management: Implications for Producers and a Conservation Agency

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ABSTRACT

Discussions of economic benefits and costs of rotational grazing and riparian zone management are ongoing but few case studies are available that summarize issues that may be of importance to producers and wildlife agencies. In spite of non-ideal study conditions, the case study presented here demonstrated that positive annual net economic benefits can result from improved pasture management without including environmental benefits. A discussion of available and required data highlights the difficulties associated with attempting to quantify whole-farm economic benefits to changes in pasture management.

Rotational grazing pasture systems and reduced access to riparian zones (areas along streams or rivers) may have the potential to provide economic and environmental benefits. Economic benefits from rotational grazing are considered to occur due to improved pasture conditions that may provide for greater weight gain of herds on pasture and/or higher stocking rates in comparison to continuous grazing systems. Environmental benefits include improved wildlife habitat and reductions in soil erosion from trampling and overgrazing. Additional environmental benefits are obtained if the pasture includes a riparian zone and the rotational system controls the herd’s access to the riparian area. A summary of the literature on the major impacts of livestock grazing on stream and riparian ecosystems may be found in Belsky et al. (1999).

A number of cattle producers in Manitoba, Canada1 and the USA2 have adopted some form of rotational grazing system and/or reduced access to riparian zones (Chorney and Josephson, 2000). Many of these producers have observed improved pasture conditions, although some controlled trials of various rotational scenarios have found varied results. While the research results are mixed, there is interest among producers, as well as environmental and producer groups, on grazing systems that provide the greatest level of sustainability from both an economic and environmental perspective (Chorney and Josephson, 2000; Lowrance et al., 2000).

While there are publications on controlled research trials that have evaluated various aspects of pasture management, there are few formal farm case studies that have presented issues surrounding the examination of economic benefits realized by producers who have changed their grazing systems from a continuous to a rotational system. Such studies would be useful to producers in identifying and outlining what such benefits are, how they are realized (i.e., through weight gains on pasture or increased stocking rates), how soon after adoption of a rotational system the benefits can be realized, the costs of such systems in comparison to the benefits, and finally, what kind of difficulties are encountered from a record keeping perspective when trying to evaluate a system change after the fact. Environmental and wildlife agencies that provide incentives or other forms of funding to producers to adopt more environmentally sustainable forms of production also require information on the possible benefits of such systems in order to analyze the feasibility and success of their funding programs (Chorney and Josephson, 2000). To put it in simple terms using the words of Lovejoy (1999, p. 370) “Does Conservation Pay?…We hope so.”

The objectives of this study are (i) to provide a brief background of some of the literature on this topic to inform case readers of some of the issues, and (ii) to introduce an educational case study that highlights the importance of and difficulties encountered in the economic evaluation of costs and benefits of adopting rotational grazing and development of riparian zones on a small sample case farm that has switched to a new production system in a nonexperimental setting.

BACKGROUND ON ROTATIONAL GRAZING

Rotational grazing involves partitioning pasture or range-land into a number of paddocks and grazing each paddock in rotation. The sequence of rotation through the paddock will usually vary from year to year. The numbers of paddocks and length of time in each paddock varies with the type of rotational system adopted and may be a function of the size and natural conditions of the pasture, the climatic conditions of the area, and the herd size. Various advantages have been ascribed to properly maintained rotational systems. As livestock are rotated through the system, the pasture is more uniformly grazed than if they were allowed to selectively graze...
the whole pasture. A period of rest for plant regrowth, avoidance of overgrazing, and less selective grazing by livestock results in more vigorous plant growth, reduced opportunities for undesirable plant species to invade the pasture, and reductions in trampling and soil erosion (Holechek et al., 1995).

Environmental benefits from improved pasture management and restricted access to riparian zones include increased quantity and quality of wildlife habitat areas and reduced soil degradation. For example, paddocks left to rest in spring are available to wildlife for reproductive purposes without danger of cattle trampling their nesting sites. Also, riparian zones are particularly susceptible to overgrazing, trampling of banks, and subsequent erosion problems, as cattle prefer these areas for the water supply as well as, in many cases, the shade and cover afforded by these areas (Holechek et al., 1995). By restricting access to the riparian areas, the improvement in vegetative cover and water quality may have a beneficial impact on fish and wildlife habitat.

In the “twice over” rotation grazing system, multiple paddocks are each grazed for two periods during the summer with the first paddock grazed in one summer being the one grazed last the previous summer. The initial cattle grazing period or “first pass” is timed to defoliate grassland plants at a pheno- logical stage that will enhance tiller development and symbiotic rhizosphere activity (Manske, 1994). The rhizosphere is the narrow zone of soil around the roots of perennial grassland plants. Increased activity of symbiotic organisms in the rhizosphere ultimately results in a greater level of nutrients available to the defoliated plant (Manske, 1994). Greater tiller development and increased rhizosphere activity enhances aboveground biomass production and, therefore, the first pass of the pasture is considered the stimulation phase. The second cattle grazing pass entails harvest of the grass (Manske, 1995).

Controlled studies of rotational grazing have found mixed results. Manske (1994, 1995) identified greater weight gains per animal with rotational grazing. Others showed greater weight gain per hectare as a result of greater stocking rates that are possible with rotational grazing (Walton et al., 1981; Em- mick et al., 1990; Morrow et al., 1990; Bertelsen et al., 1993). Still others maintain that there is no difference between the two systems (Hart et al., 1988; Chestnut et al., 1992) or that differences are due to travel distance to the water source (Hart et al., 1993). Hubbard (1951) in fact shows that under moderate stocking rates continuous systems may outperform the rotational system in terms of weight gain per calf. The variety of results found in the various studies makes comparing and interpreting these results difficult with respect to the benefits of rotational grazing over continuous grazing. The merit of rotational grazing may be highly dependent on the prior conditions and natural characteristics of the pasture as well as the degree of management provided under the two systems. Pastures that have critical areas or conditions that make them susceptible to damage or overgrazing may benefit most from the rest periods provided by rotational grazing.

**PROCEDURE AND DATA**

The Manitoba Habitat Heritage Corporation (MHHC), a habitat agency created by the government of Manitoba, works with landowners through various habitat improvement programs. Through its programs, MHHC promotes the “twice-over” rotational grazing system and has assisted producers in adopting such a system, both financially and through extension services. Producers, MHHC, and other agencies are interested in having the benefits of rotational grazing formally documented. With this end in mind, MHHC identified a producer who has recently adopted a twice-over rotational grazing system and obtained his agreement to participate in the current case study. Data on the cow-calf operation both before and after adoption of the rotational system were obtained through a personal interview with the producer. The producer’s operation and the data he had available are described below.

The participant is a cow-calf producer who resides close to Shoal Lake, Manitoba, and joined the MHHC program with a commercial beef herd of 50 cows. Calving begins after the first week of February, with the first week of March as the average calving date. Calves are weaned by the end of October and market calves are sold the first week of November every year. Approximately 16% of the heifer calves are kept to replace culled cows.

The aerial map in Exhibit 1 provides an overview of the fence system. The western half of the section (Paddocks 1, 2, and 3) is used as the main summer pasture and is characterized by mostly native grass species interspersed with shrubs and trees. Prior to establishment of the rotation system, cattle were placed on this main pasture between mid-May and the first of June with no fencing between the paddocks (i.e., Paddocks 1, 2, and 3 were grazed continuously). Between the middle and end of September the cattle were moved from the main pasture to Paddocks 4 through 6 and 9. These latter areas are used for forage, cereal, and oilseed production as well as for fall grazing once crops are harvested. Paddocks 7 and 8 are mostly bush but do provide some grazing for the fall months.

The twice-over rotational grazing system was implemented in 1996 by establishing fence lines between Paddocks 1, 2, and 3. Cattle are placed on pasture on 1 June, rotated on a 2-week basis, and removed from pasture on 1 September. With the twice-over system and three paddocks, one pass of the entire pasture requires about 6 weeks, with each paddock receiving 4 weeks of rest. Two passes of the pasture are completed during the summer months. Cattle are kept on pasture for 92 days in the rotational system, from 1 June to 1 September. Each paddock is grazed for approximately 30 days. Once removed from this pasture, cattle are again placed in the same paddocks as in the continuous system. The producer hopes to gradually increase the second pass from 2 to as much as 4 weeks per paddock, given appropriate weather and forage conditions.

The current water source for the pasture is the Birdtail River, which runs through Paddock 10. Access to the river is now limited to one site via a gravelled ramp to the river. Prior to the establishment of the rotational system, access to the river was not limited to one site. Although the fence separating the pasture from the riparian paddock (Paddock 10) was in place, cattle were able to gain access to the river on the west side of the river. By comparison, under the rotation system, pasturing on the riparian Paddock 10 is limited to 3 to 4 days in the fall.

The only other change the producer has made for improving the pasture, other than those described above, is brush and scrub cutting. As indicated in Exhibit 1, the pasture system has some shrubs and wooded area interspersed with the grassed
area. The producer began scrub cutting in 1997 to keep down the growth of the woody vegetation and to promote grass growth around the shrub areas. The hope was that grasses would eventually crowd out the shrubs within about 4 years.

The producer was able to provide data for 1995 to 1997, inclusive, for stocking rates and average weight gains of calves (see Exhibit 2). He did not have data available for years before 1995, but considered 1995 representative of his continuous grazing system. Since the producer does not own a scale, average weight gains are based on sale ticket weights in the fall, and therefore represent weight gains from birth to market, not just weight gain on pasture.

Exhibit 1. Aerial map of pasture in 1996, Shoal Lake, Manitoba. Paddocks 1, 2, and 3 were grazed continuously before 1996 and as a rotational system starting in 1996.
Animal Unit Days Per Hectare

The producer did not have data on weights of cattles, replacement heifers, or bulls, but estimated the average weight of his cattles at 635 kg. Cattle weights are used to estimate stocking rate in terms of animal unit day per hectare for each year. An animal unit (AU) is defined as one 454 kg mature cow, either dry or with a calf up to 6 months of age (Holechek et al., 1995). Therefore, with an estimated average cow weight of 635 kg, cow–calf units are assigned values of 1.4 AU. Similarly, animal units for bulls and yearling heifers can be calculated using 1.5 AU for bulls and 0.75 AU for yearling heifers (Basarab and Gould, 2000). Animal unit calculations enable comparisons across systems, as the producer pastured different types and numbers of animals over time. Exhibit 3 highlights similarities and differences across the two systems.

One might further distinguish the two pasture systems by calculating differences in forage intake using standard intake values. A mature cow, either dry or with a calf up to 6 months of age, is considered to consume 2% of its body weight of forage (dry matter) per day (Holechek et al., 1995). Bull and replacement heifer intake can again be adjusted using the differential in AU values. In the absence of actual intake data, total estimated required forage production (to proxy for assumed consumption) across years and pasture systems may serve as a crude measure of comparison across the two strategies (Exhibit 3).

ECONOMIC RETURNS

Differences in Gross Revenue

The difference in gross value of heifer and steer calf production using various pasture systems can be calculated using average sale weights and November prices (appropriate numbers are provided in Exhibit 2). The value of production will vary substantially depending on cattle prices used to determine value as shown in the range and average of the 10-year November prices. Manitoba average prices of 272 to 318 kg

heifers and 272 to 363 kg steers are, therefore, also provided. All price and cost information are in Canadian currency.

Differences in Costs of Production

Costs that were identified to differ between the two systems are (i) creep feeding, (ii) feeding and pasture costs to account for difference in days on pasture between the two systems, (iii) scrub cutting costs in 1997, and (iv) the cost of setting up and operating the new electric fence system. No attempt was made to identify and apply any differences in labor between the two systems. Installation of the fence would be a one-time event that would need to be allocated over the useful life of the fence. Other changes in labor are likely to be minor in the sense that daily cattle checking activities may be extended by several minutes to move cattle from paddock to paddock more often than previously and paying more attention to pasture condition to evaluate when to switch paddocks. No additional labor was hired and as a result, differences in returns need to be interpreted as returns to owner labor and management. Land resources and capital resources differ slightly across the systems and therefore careful attention may need to be paid to account for these changes.

Creep Feeding of Calves

Creep feeding of calves was done on a free choice basis using a mobile creep feeder. In 1995, the producer creep fed 227 kg whole oats per calf. For 1996 and 1997, the calves used 181 and 100 kg per calf, respectively. The 1996 price of $126 Mg$^{-1}$ of oats (Manitoba Agriculture, 1996) was chosen as a representative market price of feed oats for all years.

Accounting for Differential Days on Pasture and Pasture Rental

Because the pasture season on the native pasture was shorter for the rotational grazing system, the cost of feeding the animals for the additional days has to be accounted for to make comparisons between the two systems possible. Cattle were turned out on pasture at a later date in the rotation than the continuous system and were therefore kept on feed longer in the spring. Using 1996 Manitoba Agriculture cow–calf production costs, overwintering costs of $0.83 per cow per day (this includes feeding newborn calves and herd sires) may be
used. Replacement heifers carried an estimated cost of $0.80 per head per day.3

The producer also took the cattle off pasture earlier in the rotational system. Costs associated with placing the cattle on the harvested fields earlier may be reduced hay yields the following year, or increased requirements for fertilizer. Since calculation of these costs is difficult, a commonly used pasture rental rate of $0.42 per cow–calf unit per day may be used (Blawat et al., 1996). This rate breaks down to $0.32 per cow per day and $0.10 per calf per day.

One additional cost of the rotational system, which was not discussed above, is that of pasturing the replacement heifers on a separate pasture. The producer grazed the replacement heifers at no charge from his neighbor from 1 June to 1 September for 1996 and 1997. The replacement heifers joined the remainder of the herd on Paddocks 4 through 9 for the remainder of the pasture season.

**Scrub Cutting**

As a further means to improve pasture condition, the producer began scrub cutting in 1997. The producer stated that he likely would have started scrub cutting even without the change to the rotational system. Further, dramatic changes in forage production due to scrub cutting would likely not have appeared the first year.

**Fencing Cost**

Total fencing costs for separating the native pasture into three paddocks using two strand electrical wire was $1800. A useful life of 10 years is assumed with no maintenance cost and a salvage value of $800 at end of the fifth year. Again, no labor charges are included. The producer was refunded some of these costs.

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3 Manitoba Agriculture (Blawat et al., 1996) uses a winter feeding period of 225 days for the average producer. During this time cattle are kept in corrals and fed rations made up of hay, straw, and grain. Hay costs for this period are given as $180 per cow or herd sire.

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In addition, averaging across years would remove seasonal weather differences, at least for the rotational system. Since the producer has been in the cattle business for some time, his statement regarding 1995 being a representative year is taken at face value. Second, the discussion of the case study implies that a partial budgeting approach can be used to answer this question. Rather than estimating returns to resources with the old system (e.g., $50 per bred cow) and comparing them with those of the new system (e.g., $75 per bred cow), only differences in revenues and costs across the systems are analyzed to estimate returns to the system change (e.g., $25 per cow). By doing this, the analyst can calculate returns to additional resources that may be required but could not be accounted for in the analysis (i.e., added owner labor and management). Since a whole-farm comparison is envisioned across systems and a change in scale of production was also introduced (moving from 50 to 70 bred cows), partial returns above specified costs per bred cow offer a reasonable and somewhat scale independent criterion by which to judge the systematic changes. Further, only those changes that were measured can be included in the analysis.

Revenues would be increased with higher weaned calf sales due to changes in the calf weights. The split between heifer and steer calves as well as the calving rate (number of calves weaned per bred cow) changed across years; therefore, the analyst may wish to use the 3-year average calving rate (97.24%) and sex ratio (52.73% heifers) to determine the impact of heavier calves with the new system. The average gain in calf weights was 26 and 7 kg for heifers and steers, respectively. Further, price data presented in Exhibit 2 are average, minimum, and maximum prices. The 10-year average price should probably be used to present revenue changes that would not be unduly influenced by cyclically high or low cattle prices. Seasonal price fluctuations are not an issue, because both systems have cattle marketed in November. The analyst might consider looking at minimum calf prices to identify whether the system might lead to cashflow pressure during a low price year. On a per bred cow basis, additional sales are $34.21 using average information for prices, calving rate, and sex ratio (Exhibit 4). The system change did not lead to a reduction in sales.

Exhibit 4 also outlines changes on the cost side. The system change resulted in the following: (i) Cows, calves, and replacement heifers were fed a winter ration of hay and grain for an extended period in the spring (approximately 1 week) due to delayed access to the pasture; (ii) A shortened feeding period when compared with the continuous grazing system on Paddocks 1 to 3, which in turn meant an increased stocking rate and pasture period for Paddocks 4 to 9. (Costs of this added pasturing may be estimated using pasture rental rates for the estimated 3 weeks of additional grazing by the added livestock. To determine changes in average pasture cost per bred cow, the total change in pasture costs is divided by the 70 bred cows); (iii) The replacement heifers were grazed on a neighbor’s pasture for the 92 days that replacement heifers used to spend on Paddocks 1 to 3; (iv) Additional investment in fencing equipment. Scrub cutting was also introduced in 1997 but would not have been expected to result in added pasture production for the same year. Mowing expenditures are also excluded from the analysis; (v) Finally, the system change...
has lead to a reduction in supplemental oats fed to the calves with a creep feeder.

The above system changes have thus lead to a total increase in returns above specified costs of $28.65 per cow exposed. These returns are due in part to larger land resources used (replacement heifers are custom grazed) and increased owner labor and management (installation of pasture improvements and changes in annual labor requirements—moving cattle from paddock to paddock, pasture checking, and so forth). In\-\investment per cow has also slightly increased because of pasture improvements that were partially considered (cost share in the investment is not listed and labor costs are not explained). These returns, therefore, need to be interpreted with care. A producer and/or conservation agency interested in determining whether or not to switch to the new pasture management strategy would take the return estimate of $28.65 per bred cow, adjust prices and costs in Exhibit 4 to fit their situation, multiply by the number of bred cows in the herd, and see if the added returns would justify additional labor and management efforts. How much of these returns are attributable to rotational grazing is not quantifiable, however, because there are a large number of limitations to the study. A discussion on these issues follows.

Limiting the study to one producer is acceptable for the case study approach taken here, but does not allow for any general conclusions of the merits of rotational grazing over continuous grazing. Pasture conditions and their responses to different management techniques will vary substantially by location. Limiting the number of years to 1 year for the continuous grazing system and 2 years for the rotational system also places serious restrictions on the results. The producer felt 1995 was representative of his continuous grazing system, but formal documentation of 3 years or more would lend more weight to average weight gain expected under the continuous system. Similarly, only 2 years of data under the rotational system does not give enough indication that increased weight gains were due to the rotational system or were partially, or even entirely, the result of other unaccounted for factors. For example, pasture production is expected to change from year to year due to weather. The provincial average for tame hay yields for Manitoba was 4.2 Mg ha\(^{-1}\) in 1996 compared with 3.0 Mg ha\(^{-1}\) in 1995 (Manitoba Agriculture, 1996). Higher precipitation and other weather-related factors, not associated with the rotational system, could have contributed to better pasture conditions for the 2 years under rotational grazing. Paddocks 4 through 9 were also utilized to a larger extent with the rotational system.

As was mentioned earlier, average weight gains of calves were based on average sale ticket weights, and thus actually indicate weight gain from birth to market. This included time before cows and calves were placed on Paddocks 1 to 3 and time after they were taken off those paddocks, and therefore is not solely the weight gain realized due to rotational grazing. For example, if calves were born, on average, in the first week of March and were sold the first week of November, then they were approximately 245 days old when sold. In the continuous system, cattle were on Paddocks 1 to 3 for 122 days, representing only 50% of the time from birth to market, and in the rotational system, cattle were on that section of pasture for only 92 days, representing only 38% of the time from birth to market. While the producer is confident that the entire change in weight gain is due to the change in pasturing method, a more accurate estimate of changes in weight gain could be obtained by weighing cows and calves just before and after their time on the main pasture. The reader may wish to consult the literature cited previously or find additional literature on the topic.

Also, since weight gains of heifer calves kept by the producer to replace culled cows were not available, average weight gains for market calves were extended to these calves. However, the producer kept what he considered his best heifers

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**Exhibit 4. Annual partial returns per bred cow for switching to new pasture management.**

<table>
<thead>
<tr>
<th>Added revenues</th>
<th>$34.21</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change in average value of beef produced per bred cow after adjusting to 47/53 steer and heifer production and a 97% calving rate in $ bred cow(^{-1})</td>
<td>$27.20</td>
</tr>
<tr>
<td>Avg. change in value of heifer calves produced per cow 97.24% × 52.73% × (305 kg − 279 kg) × $2.04 kg(^{-1})</td>
<td>$7.01</td>
</tr>
<tr>
<td>Avg. change in value of steer calves produced per cow 97.24% × 47.27% × (334 kg − 327 kg) × $2.18 kg(^{-1})</td>
<td></td>
</tr>
<tr>
<td>Reduced revenues</td>
<td>($0.00)</td>
</tr>
</tbody>
</table>

**Added costs** ($16.16)

| Added feeding costs in spring for delayed release to pasture using cost of production estimates and average placement date of third week in May with the conventional system compared with the June 1 starting date with the rotational system. | $5.81 |
| Added spring feeding costs in $ bred cow\(^{-1}\) 1 week @ $0.83 day\(^{-1}\) | $0.90 |
| Added replacement heifer feeding cost adjusted to 1 replacement heifer per 6.25 bred cows 1 week @ $0.80 day\(^{-1}\) / 6.25 | |
| Pasturing replacement heifers on another pasture adjusting the grazing cost by AU and adjusting for cow replacement rate. Replacement heifer pasture cost in $ bred cow\(^{-1}\) 92 days @ 0.75 AU heifer\(^{-1}\) @ $0.32 AU day\(^{-1}\) / 6.25 | $3.53 |
| Added pasturing (3 weeks) on Paddocks 4 through 9 adjusted for number of bred cows. Added cows (20 @ $0.32 day\(^{-1}\)) | $134.40 |
| Added calves (21 @ $0.10 day\(^{-1}\)) | $44.10 |
| Added herd sire (1 @ $0.48 day\(^{-1}\)) | $10.08 |
| Added replacement heifers (3.2 @ $0.24 day\(^{-1}\)) | $16.13 |
| Total added costs associated with extended grazing and additional livestock | $204.71 |
| Added pasture charges in $ bred cow\(^{-1}\) ($204.71 / 70) | $2.92 |
| Initial outlay ($1800) and salvage value ($300) capitalized over 5 years to arrive at an annual cost of fencing system with the assumption that 70 cows can be maintained on the rotational system. The capital recovery method is used (Boehlje and Eidman, 1984). Annual capital cost @ 4% real interest per year in $ bred cow\(^{-1}\) ($1800 − $800) / 70 + ($800 × 0.04) / 70 | $3.00 |
| Reduced costs | $10.60 |
| Creep feeding costs are expected to decline with improvements in pasture quality. Average oats consumption savings per calf and calving rate are used with the 1996 oats price. Supplemental feed savings in $ bred cow\(^{-1}\) 97.24% @ [227 kg − (181 kg + 100 kg)/2] @ $0.126 kg\(^{-1}\) of oats | $10.60 |

**Total difference in annual net returns in $ bred cow\(^{-1}\)** $28.65

\(^1\) Values are in Canadian currency.
as replacements and, therefore, using the average gain from market calves likely underestimates the weight gain on these replacement heifer calves.

Finally, the producer added 20 cows and 1 bull to his herd at the beginning of the rotation program. Depending on the cows and bulls added, this could have improved the genetic foundation of the herd and produced, on average, heavier calves. Since weight gain of individual calves were not provided this could not be analyzed.

As was discussed in the “Background on Rotational Grazing” section, several studies have found improved pasture conditions after adopting a rotation strategy with greater biomass production and/or improved species composition. In the present study, the producer has noticed an increase in desirable grass species, in particular, western wheatgrass (Agropyron smithii Trin. & Rupr.), and a decrease in undesirable invader species within 2 years. Improvements have also been noticed to the riparian area since limiting cattle access to the river. No attempt was made here to quantify or even record any improvements or changes to the riparian area. Improvements in water quality and nesting opportunities are expected, however. Had additional returns to improved pasture management not been realized, the conservation agency would then need to quantify some of the environmental benefits that can be realized to determine how much they need to subsidize producers for changing their pasture management. This would be subject to further study. In the above case, positive returns are available without accounting for environmental benefits. As long as these returns are sufficient to motivate producers to change production practices, the conservation agency need not intervene with subsidization.

ACKNOWLEDGMENTS

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REFERENCES


