Effect of Work and Urea-Molasses Cake Supplementation on Live Weight and Milk Yield of Murrah Buffalo Cows

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ABSTRACT : Two experiments were carried out to investigate the effect of Murrah buffalo cows pulling sledges under field conditions on milk production and milk composition. In Exp. 1, 24 buffaloes in the fourth month of lactation were used. They were allotted to four treatments according to a 2×2 factorial arrangement: work or no work, and with or without urea-molasses cake supplementation (700 g/animal/day). Feeds consisted of 20 kg fresh elephant grass (18% DM), 2 kg rice bran per day and rice straw ad lib. The animals worked in pairs three hours per day (work done: 3464±786 kJ/d) five days a week for three months. Three teams worked in the morning and the others worked in the afternoon in the same day. The following day the working times were switched. In Exp. 2, 16 lactating Murrah buffalo cows in the sixth month of lactation were allotted to two groups (work and no work). They were fed with fresh ruzi grass (*Brachiaria ruziziensis*) ad lib. supplemented with 2 kg rice bran and 700 g urea-molasses cake. The working regime was similar to that of the first experiment (work done: 3753±879 kJ/d) and they worked for two months. In the first experiment, there was a small but significant drop ($p<0.05$) in milk yield from 3.5 to 3.0 kg/day due to work, but there was no supplementation effect. The working buffaloes lost 5.2 kg whereas the non-working animals gained 9.7 kg during the three months ($p<0.05$). Supplementation increased live weight by 9.9 kg as compared to -5.4 kg for those not supplemented ($p<0.05$). Milk composition was not affected by the treatments. In the second experiment, daily milk production was similar for both treatments and approximately 3 kg. No significant differences were found in milk composition or in live weight changes for working and non-working groups, respectively. It was concluded that work may cause a reduction in milk yield and a loss of live weight on a poor rice straw diet but that an appropriate supplementation can alleviate this situation. *(Asian-Aus. J. Anim. Sci. 2000. Vol. 13, No. 9 : 1329-1336)*

Key Words : Murrah Buffaloes, Work, Supplementation, Live Weight and Milk Yield

INTRODUCTION

The use of animal power is today considered by many people to be archaic and inefficient and agricultural development is equated with the use of machines. Despite more than 50 years spent in promoting tractors in developing countries, the development gap between highly industrialized, wealthy countries and those with weak and highly-dependent economies has increased (Chirgwin, 1997). Lawrence and Zerbini (1993) stated that multi-purpose animals (animals for work, milk and meat) are useful for small-holder farmers. The Swamp buffaloes are popular as draught animals whereas the Riverine buffaloes are predominantly used for milk production in the South Asian countries. Nevertheless, draught power and meat from the Riverine buffaloes are equally important but not yet fully exploited (Gill, 1998). In Vietnam, Swamp buffaloes are used mainly for work, while the Riverine type Murrah buffaloes have been introduced from India mainly for milk production. This single purpose approach has reduced the economic potential of the Murrah, making it less competitive with the tractors. Traditional feeding systems e.g. extensive grazing and the feeding of crop residue without supplementation have dominated and caused slow growth rates, low working performance and poor health in the dry and working seasons. In serious cases, farmers have been forced to sell the animals for slaught (Thu et al., 1993). Supplementation of working and lactating cattle have been studied by Zerbini and Gemeda (1993) in Ethiopia, but some uncertainty exists at the present time about the effect of work on milk production. While some authors consider that well-fed cows suffer no adverse effects from working, it would appear that milk yield and fertility may be affected in poorly-fed animals (Zerbini and Gemeda, 1993).

Supplementation of ruminants is necessary to improve their performance on low quality diets. The multi-nutritional block used is a nitrogen and energy supplement to ruminants and there have been positive effects on both beef and milk production (Preston and Leng, 1987). Urea-molasses cake (UMC) is produced as a soft and small block, and may improve significantly the working performance and health of buffaloes given poor quality diets under both experimental and village conditions (Thu et al., 1993).

The objective of this study was to evaluate the effect of supplementation with UMC on milk production in working and non-working Murrah

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buffaloes.

MATERIALS AND METHODS

The study included two experiments which were carried out at the Center for Large-scale Animal Research, Song Be Province, Vietnam in 1996.

In Experiment 1, 24 Murrah buffalo cows in the fourth month of lactation were used. They were allotted to four treatments according to a 2×2 factorial arrangement, work or no work, and with or without urea-molasses cake supplementation. The cake contained 37.9 "B" molasses, 7.6 urea, 7.5 coconut oil meal, 3.8 salt, 39.4 rice bran, 3.8 bone meal, and 0.15 trace minerals on an air dry basis (%). The mixture was molded into cakes weighing 1.4 kg with crude protein (CP) content of 385 g/kg dry matter (DM) and calculated metabolizable energy (ME) value of 7.17 MJ/kg (NIAH, 1995). The animals were fed 20 kg fresh elephant grass, 2 kg rice bran, 700 g UMC per day according to Thu et al. (1993) and rice straw *ad libitum* in individual pens. They were fed twice a day (7:00 and 14:00). The animals worked in pairs, three hours per day, five days a week for three months by pulling loaded sledges. Three teams worked in the morning and the other three worked in the afternoon in the same day. The following day the working times were switched. The buffalo cows had been trained to work for one month before entering the experiment.

In Exp. 2, 16 lactating Murrah buffaloes in the sixth month of lactation were allotted to two groups (work and no work). They were fed fresh ruzi grass (*Brachiaria ruziziensis*) *ad libitum* and were supplemented with 2 kg rice bran and 700 g urea-molasses cake per day per animal. The feeding times and the cake composition were the same as in Exp. 1. Animal working regimes were similar to the first experiment and work was carried out during two months. The animals in this experiment were first trained and worked continuously for two months. They entered the experiment after a 2-week rest.

In both experiments, draught force was measured each working time using a load cell (type F241-Z0447, Novatech, UK) connected to a readout. Pulse, respiration rate, and body temperature were measured before and after working. Relative humidity and ambient temperature were also recorded. When buffaloes had finished working, they were sprinkled with water for one minute before resting. Milk production and intake of feed and water were recorded daily. Milk samples were collected weekly and then analyzed for fat, lactose and protein content according to the American Public Health Association (1985), AOAC (1960) and Pyne (1932). Animals were weighed weekly on two consecutive days in the morning before feeding. Feeds and refusals were collected daily and pooled weekly for analysis of dry matter (DM), crude protein (CP), neutral detergent fiber (NDF), acid detergent fiber (ADF), lignin and ash following procedures of AOAC (1990) and Van Soest et al. (1991).

All data from Exp. 1 were subjected to an analysis of variance (ANOVA) by using the General Linear Model (GLM) procedure of Minitab (1998). When the F test was significant ($p<0.05$) Tukeys test for paired comparison was used (Minitab, 1998). Results from Exp. 2 were analyzed by the 2-sample t-test of the Minitab program (Minitab, 1998).

RESULTS

The chemical compositions of feeds in the Exp. 1 and Exp. 2 are shown in table 1. The ruzi grass used to feed the animals in Exp. 2 had higher DM, NDF, ADF and lignin content compared to those of the elephant grass in Exp. 1, though they were similar in CP content.

Experiment 1

The average draught force of a pair of buffaloes was 454 N. The work done per 24 h and energy expended for work as a multiple of maintenance were 3464 kJ and 0.48, respectively. The experiment was carried out in the dry season and after working in the morning. The average body temperature, pulse and respiration rates per minute were 39.9℃, 66 and 53.0 and in the afternoon they were 39.9, 65.4 and 45.3, respectively. There were no significant differences between morning and afternoon measurements. The ambient temperature was 36.6℃ in the morning and 33.6℃ in the afternoon after the animals had been working.

The results shown in table 4 indicate a significant ($p<0.05$) treatment difference in live weight change

Table 1. Chemical compositions of feeds in Exp. 1 and 2

Feed	DM	CP	NDF	ADF	Lignin	Cellulose	Hemicellulose	Ash
	%	% DM						
Rice straw	88.4	3.4	70.3	41.2	13.2	28.0	29.1	15.2
Elephant grass	18.0	9.9	68.2	37.6	9.07	28.5	30.6	7.31
Ruzi grass	25.5	9.8	78.3	41.0	11.1	29.9	37.3	9.9
Rice bran	87.6	10.7	11.5	4.81	0.55	4.26	6.69	11.3

(LW) during the experimental period for the working and non-working buffaloes of -5.2 kg and 9.7 kg, respectively. Similarly, there was a significant ($p<0.05$) difference in LW change between the supplemented and non-supplemented buffaloes of 9.9 kg vs -5.4 kg. Milk production of the working group was significantly lower than in the non-working group (3.0 kg vs 3.5 kg/day). But, there was no difference due to supplementation. Milk compositions were unaffected by any of the treatments. Similarly, there were no significant differences in feed and water intake among the groups.

Experiment 2

In the Exp. 2, the buffalo pairs exerted an average draught force of 505 N and work done was 3,753 kJ. These were slightly higher values than those of Exp. 1. Animal body temperatures increased in Exp. 2 by 2℃ during work, but the pulse rate of the animals after working was higher than in the Exp. 1 both in the morning and in the afternoon. Respiration rate was lower in Exp. 2 than in Exp. 1 after morning work, while in the afternoon, respiration rates were similar in both experiments (tables 5 and 6).

Change of LW was not significantly different between working and non-working buffaloes (table 7) and there were no significant differences in milk composition. However, the feed intake per day (g DM/kg $LW^{0.75}$) of the working buffaloes was significantly higher than that of non-working animals (99.0 vs 95.0).

Table 2. Average performance of lactating buffaloes working in pairs with sledges three hours per day for three months in Exp. 1 (n=12 pairs)

Item	Mean ± SEM
Live weight, kg/pair	904 ± 44.5
Walking speed, m/s	0.88 ± 0.01
Draught force, N	454 ± 0.98
Work done, kJ	3464 ± 768
Work done, kJ/kg$LW^{0.75}$	21.1 ± 0.49
Power, W	387 ± 80
Energy expended for work as a multiple of maintenance*	0.48 ± 0.03

* NE for work/NE for maintenance (Lawrence and Pearson, 1999).

DISCUSSION

In a previous study in Colombia with female cattle and Murrah buffaloes working a sugarcane crusher under shade, the draught force, work done and crushed cane were 589 N, 2680 kJ and 389 kg/day, respectively, for the lactating buffalo pairs. The pulse and respiration rates of the buffaloes when working were significantly higher compared to values before working. There was also a slight rise in body temperature during work of 0.4℃ (Thu et al., 1996). In both Exp. 1 and 2 of the present study, the work done was implemented in the sun and it was also higher and therefore the increase in body temperature during working time was also higher. Further more, the high ambient temperature in the dry season increase the physiological stress of the water buffaloes causing an increase in body temperature, pulse and respiration rates of the animals.

Preston and Leng (1987) argued that if a cow is to work without a reduction in milk yield, it will require feeds that can offer more glucose and long-chain fatty acids. Exercise may reduce yields of milk protein and lactose, but not necessarily the yield of fat and volume. However, Matthewman et al. (1989) reported that milk yield and milk lactose have been shown to decline only on working days but recover rapidly on non-working days. According to Leng (1985; cited by Matthewman et al., 1989) glucose availability may be a constraint to maintaining lactation performance during work. Matthewman et al. (1989) concluded that a major response to exercise is a competition for substrates required for milk protein and lactose synthesis but that severe reduction in lactation performance with exercise may be only transitory. Data collected over two years showed that working non-supplemented cows gave the lowest milk yields when compared with non-worked supplemented and non-supplemented and working-supplemented cows (Pearson et al., 1999). Zerbini et al. (1998) suggested that work, with poorly-fed buffaloes is not a feasible option for a production system involving the use the lactating cows for draught.

Table 3. Ambient temperature, body temperature, pulse rate and respiration rate before and after working (W) in Exp. 1 (SEM)

Item	Morning		Afternoon	
	Before working	After working	Before working	After working
Ambient temp., ℃	27.8 ± 0.11	36.6 ± 0.6	38.1 ± 0.18	33.6 ± 0.31
Body temp., ℃	37.9 ± 0.12	39.9 ± 0.19	38.2 ± 0.14	39.9 ± 0.18
Pulse rate, beats/min	47.6 ± 1.9	66.3 ± 1.2	82.9 ± 0.73	65.4 ± 41.1
Respiration rate, breaths/min	20.6 ± 0.41	53.0 ± 3.0	25.5 ± 0.76	45.3 ± 2.1

Table 4. Change of live weight (LW) during the period, daily yields of milk, butter fat, lactose and protein, and daily fodder and total water intake of buffaloes working in pairs with sledges three hours per day for three months in Exp. 1

Item	Work	No work	Supplementation	No supplementation	Significance level		
					W	S	W*S
Change of LW, kg/period	-5.2	9.7	9.92	-5.4	*	*	ns
Milk yield, kg/d	3.0	3.5	3.3	3.2	*	ns	ns
Fat yield, g/d	353	343	355	342	ns	ns	ns
Protein yield, g/d	176	164	169	165	ns	ns	ns
Lactose, g/d	154	177	173	158	ns	ns	ns
Fodder intake, g DM/kg $LW^{0.75}$	87	86.5	87.4	86.2	ns	ns	ns
Water intake, l/kg DM feed/d	3.7	3.53	3.70	3.53	ns	ns	*

* Significant difference ($p<0.05$).
ns: no significant difference.

In Exp 1. where the animals were fed 20 kg elephant grass and rice straw *ad libitum* as a basal diet, there was a significant loss in live weight (LW) in the working buffaloes but a significant improvement in LW of the supplemented buffaloes. In an earlier study, Thu (1994) reported that animal live weight was reduced during working weeks, but that the reduction did not exceed 4% of live weight. Lawrence and Zerbini (1993) found that cattle were able to work and produce some milk with some weight loss and, they showed a compatible loss of body weight associated with a reduction of feed consumed during working period. Milk production was significantly lower in the Exp. 1 working group than in the non-working group, but there was no difference due to supplementation. These observations confirm those of Matthewman et al. (1989) and Zerbini et al. (1998). However, there was no significant difference in yield of lactose per day, although it was higher in the non-working and supplemented groups as compared to the working and non-supplemented groups (177 and 173 vs 154 and 158 g, respectively. In the Colombian study (Thu et al., 1996), there were significant decreases in buffalo live weights during the three working weeks. There was also a significant reduction of milk yield during the three working weeks as compared to the week before work ($p<0.01$). After the first working week, however, milk production became more constant and recovered quickly during the resting week ($p>0.05$). Milk fat content did not change as an effect of work.

In Exp. 2, the animals were fed fresh ruzi grass *ad libitum*, 2 kg rice bran and 700 g UMC per day. There was no significant difference in live weight changes and milk yields between working and non-working groups, but the fodder intakes were significantly higher in the working group ($p<0.05$). Milk composition and total water intakes were similar to the first experiment, but milk yield was lower as the animals were in a later stage of lactation. In this experiment the buffaloes were also more familiar with working due to a longer training period. The animals could consume more feed due to the better basal diet supplied (green feed) and less effects were caused by working. In an experiment feeding millet stover and some concentrates to oxen, Fall et al. (1997) reported that work did not affect intake of millet stover, apparent digestibility and rate of passage of digesta through the gastro-intestinal tract of the oxen supplemented with concentrate. However, from results of studies on working cows fed hay and supplemented with concentrate, wheat middling, salts and minerals, Zerbini et al. (1995) showed that hay and total DM intake were greater for working cows than non-working cows and greater for the supplemented cows than the non-supplemented cows. Thus roughage and total feed intake of working animals will vary depending on their nutritional status, work intensity, roughage quality and availability of supplements.

Molasses is a concentrated source of fermentable carbohydrate that is available in many parts of the

Table 5. Average performance of lactating buffaloes working in pairs with sledges three hours per day for two months in Exp. 2 (SEM)

Live weight, kg	823±33.2
Walking speed, m/s	0.83±0.02
Draught force, N	505±1.2
Work done, kJ	3753±879
Work done, kJ/kg $LW^{0.75}$	24.5±0.55
Power, W	420±10
Energy expended for work as a multiple of maintenance*	0.49±0.08

* NE for work/NE for maintenance (Lawrence and Pearson, 1999)

Table 6. Ambient temperature, body temperature, pulse rate and respiration rate before and after working in Exp. 2

	Morning		Afternoon	
	Before working	After working	Before working	After working
Ambient temp., ℃	24.6 ± 0.40	34.0 ± 0.83	38.5 ± 0.23	35.1 ± 0.72
Body temp., ℃	37.7 ± 0.05	39.7 ± 0.16	38.0 ± 0.06	40.0 ± 0.16
Pulse rate, beats/min	51.9 ± 0.84	69.1 ± 1.4	51.7 ± 0.74	69.7 ± 1.0
Respiration rate, breaths/min	18.0 ± 0.67	43.9 ± 2.8	21.2 ± 1.5	45.4 ± 2.9

tropics. It can be used as a basis for intensive cattle fattening and as a carrier for urea, minerals and other nutrients (Preston and Leng, 1987). Molasses can be mixed with urea and directly sprayed on rice straw for feeding ruminants. Using urea-molasses cakes for feeding working buffaloes and cattle can reduce weight loss, improve working capacity and health during the working season (Thu et al., 1993). UMC supplementation of native swamp buffaloes may increase ploughing capacity and speed of ploughing. As compared to our previous trials with nitrogen and mineral supplementation in the form of a loose mash or licking blocks to buffaloes, the experiments with the cakes produced more satisfactory results in animal performance (Thu et al., 1993). Further more, a comparison between the normal licking block and the UMC reveals a superior nutrient composition of the UMC, improved shelf life, easier transport in remote areas and higher acceptability and intake by buffaloes. These observations have been confirmed by Vietnamese farmers and local extension workers (Thu et al., 1993). In the present study, the supplemented groups received 700 g UMC per day, equivalent to 221 g CP from urea, coconut meal and rice bran and 5.02 MJ ME mainly coming from molasses. In Exp. 1, it was evident that it was the supplementation with UMC that prevented the loss of live weight of the working buffaloes. In their review, Sansoucy et al. (1995) stated that the urea-molasses block tends to give superior results compared to urea supplied by spraying on straw. The reasons for the difference in response may have been the extra energy supplied by molasses and/or a stimulatory affect on the other ingredients in the blocks on the rumen ecosystem.

Stem et al. (1994) have pointed out the importance of synchronising energy fermentation with nitrogen availability for optimising microbial protein synthesis (MPS). Most bacteria can use nitrogen from ammonia for protein synthesis. Besides this, cross-feeding among bacteria may provide substrates to certain organisms for a longer time over the feeding cycle. Peptides and amino acids improve MPS when substituted for ammonia in both in vitro and *in vivo* studies (Wallace et al., 1999). But stimulation of bacterial growth by peptides and amino acids varies with the species of bacteria and energy source. Thus, supplementation with non-protein nitrogen (urea), readily fermentable energy (molasses), protein (oil seed cakes or rice ban) and minerals may support an increasing growth of microbes, which is useful for improving nutrition of the host animals. In UMC supplemented swamp buffaloes an increase was found in ruminal NH_3-N, bacterial and protozoa population and also feed intake increased (Thu, 1997). Wanapat et al. (1999) suggested that high quality feed blocks should include molasses, urea, cassava, oil seed meals, minerals, and sulfur for lactating cows. Such blocks had been found to increase roughage intake, milk yields, milk fat content and give a high economical return. Chowdhury and Huque (1995) favored another form of supplement called urea-molasses straw (straw enriched with 3% urea and 15% molasses) which they found to be more promising compared to the urea-molasses block during field application.

The energy requirements of the supplemented working buffalo groups were estimated according to Lawrence and Pearson (1999) and the supply of energy in the feeds according to NIAH (1995) these estimates showed that in Exp. 1 feed intake was able to satisfy 44.3 MJ NE for maintenance and work. However, the milk produced required 16.6 MJ NE

Table 7. Change of live weight (LW) during the period, daily yields of milk, butter fat, lactose and protein, and daily fodder and total water intake of buffaloes working in pairs with sledges three hours per day for two months in experiment 2

Item	Work	No work	Significance level
Change of LW, kg/period	3.9	8.3	ns
Milk, kg/d	3.0	3.1	ns
Fat, g/d	291	261	ns
Protein, g/d	138	134	ns
Lactose, g/d	143	160	ns
Fodder intake, gDM/kg $LW^{0.75}$	99.0	95.0	*
Water intake, l/kg DM feed/d	2.3	2.1	ns

* Significant difference (p<0.05)
ns: no significant difference

resulting in a 1.7 MJ NE deficit. The same calculation applied to Exp. 2 gave 42.5 MJ NE for maintenance and work, 15.9 MJ NE for milk production and a surplus of 5.53 MJ NE for body gain of the buffaloes. Calculations explained the observed live weight gain of the working buffaloes in Exp. 2 and the weight loss of the working and lactating buffaloes in Exp. 1. A weight loss could possibly have been avoided if the cake had been given at a higher level than 700 g. We have observed considerably high intakes in buffaloes and cattle of the soft cake. In contrast, Hosmani et al. (1995) reported that the hard urea-molasses-mineral blocks (UMMB) were only consumed at a rate of 350 g/d in adult male buffaloes with free access to the block. This was not sufficient to meet the animal requirement with wheat straw was used as a sole basal diet. Similarly, CP intake was insufficient to meet the protein requirements for the maintenance of buffalo steers when the hard UMMB and rice straw were offered (Reddy et al., 1998). Although, the rice straw intake of the supplemented UMC buffaloes was non-significant higher than the un-supplemented buffaloes in Exp. 1, the increase of total feed intake supported for nutrient requirements of the working and lactating buffaloes. The increase of fodder intake by urea-molasses supplementation was also reported by other authors (Chowdhury and Huque, 1995; Chenost and Kayouli, 1997; Wanapat et al., 1999).

The present study was carried out during the dry and early rainy season from February to July. This is not an estrus season of the buffaloes, so no estrus was observed in either the experimental buffaloes or in those outside the experiment. However, our experiences from the study in Colombia (Thu et al., 1996), have been that the ovarian activity of buffalo cows may be limited during the working period. This has also been reported in cows by other authors (Teleni et al., 1989; Jarbar, 1993; Zerbini et al., 1993; Pearson et al., 1999). Winugroho and Teleni (1993) concluded that in draught cows, body condition score is a better indicator of nutritional status and productivity than live weight. In swamp buffaloes the depletion of body reserves is a major determinant of ovarian function and but work per se does not appear to have any significant effect (Winugroho and Teleni, 1993). Working buffaloes with a body condition score of 2, based on the scale used (from 1 to 5), would most likely have abnormal ovarian function (Winugroho et al., 1993). Results from some countries where there is a chronic feed shortage (e.g. Bangladesh) have shown that females are replacing males as draught animals (Dolberg, 1983; cited from Preston and Leng, 1987). Lawrence and Zerbini (1993) reported that body weight loss of draught cows could be reduced from 0.7 to 0.3 kg/day with supplementary feeding. This has also been shown to improve reproductive performance by about 65%. It is therefore important to develop specific working and feeding regimes, which can induce normal estrus during the early postpartum period.

Female draught animals are used for a variety of work purposes, including cultivation (ploughing and harrowing), harvesting, threshing, transportation, powering machines such as mills and water-drawing devices and for riding. A large portion of draught power available is often unused for much of the year as a result of the seasonal demand for draught power. The use of draught cows for short periods, however, can still be an efficient use of feed resources, unless there are alternatives which would provide the same draught power either more cheaply or with additional benefits (Pearson and Lawrence, 1992). *Bos indicus* and *Bubalus bubalis* cows can be truly multi-purpose animals producing a range of commodities which are important to the farmer (Mathers et al., 1985). The use of animals for milk, meat and draught, has shown potential for increasing farm productivity and income (Zerbini and Gemeda, 1993). Zerbini et al. (1993) also reported that crossbred bovine cows could play an important role as dual purpose animals in the Sub-Saharan African farming system. In particular, this could contribute to a better utilization of already scarce feed resources instead of using many oxen only for work. In Vietnam, agricultural production is mainly based on small farmer households, and draught animal power has a very important role in crop production. Thus, cows could be used for work beside for milk and meat. This could increase farm activities and improve benefit for farmers in different agricultural systems.

CONCLUSIONS AND IMPLICATIONS

Murrah buffalo cows may be used for work and can then exert a work done of 3400-3700 kJ per day and produce 3-4 kg of milk. Milk production and body weights of the buffaloes were reduced when they are fed poor diets but this situation was improved by supplementation. Farmers could use Murrah buffalo cows for work and milk, but urea-molasses cake should be used to supplement the animals when working. Further, long-term experiments to study the effect of work and supplementation on reproduction should be undertaken under field conditions.

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