Total Ranch Planning should increase with experience and understanding. Traditionally, we have trained ranchers in Animal Science, Range Management, Wildlife Management, Agricultural Economics, etc. All of these disciplines must be molded in a logical framework. Total Ranch Benefits can only be obtained by thinking and acting in a Total Ranch context. Over-emphasis in any phase detracts from the ranch operating as a unit and often over-extends some resources while under-utilizing other resources. The manager becomes a resource manager rather than a cattleman, sheepman, rangeman, etc.

The Total Ranch Management concept provides an integrated approach to ranch management. Success or failure still depends on management. Technologies, computers, and other "advancements" cannot replace management. They are simply tools and alternatives available when and where needed.

Literature Cited


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Nuclear Accidents and Rangelands: The Effect of Chernobyl on the Grazing Economy of North Wales

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Fortunately our experience with the effects of leakages of radioactive materials resulting from accidents at nuclear power stations is extremely limited. When such an accident does occur, as was the case in Chernobyl, USSR, on April 26, 1986, it provides information which can be utilized to reduce the consequences of any future accident. A substantial quantity of radioactive material was released into the atmosphere as a result of the explosion at the reactor. It was almost a week later on May 2 that radioactivity from Chernobyl was detected in the United Kingdom, some 2,000 km from the site of the accident. Over the weekend of May 2 and 3 some areas of North Wales, Scotland, and Cumbria in northwest England received a heavy rainfall which washed a considerable amount of the Chernobyl material out of the atmosphere and deposited much higher concentrations of radioactive substances on the ground than were experienced in most of the remainder of the United Kingdom. Sheep and cattle grazing are the predominant form of agricultural production in the areas of heavy contamination. Increased radiation levels had a major and long-lasting effect on both the existing grazing system and the local livestock economies. British officials attempting to deal with the problem were hampered at the outset by poor or non-existent information. The experience gained, however, provides considerable insights into the likely effects of future low level nuclear contamination of rangelands and the types of policies which should be implemented to minimize the resulting disruption.

The areas of North Wales affected by radiation include the island of Anglesey and parts of the Welsh counties of Gwynedd, Clywd and Powys, an area of approximately 100 km west to east and 90 km north to south. Within the area there are approximately 5,100 farms. Livestock raising is the predominant agricultural activity. Dairying is conducted on the better land with sheep or mixed cattle and sheep operations concentrated on the poorer uplands and hills. It is the latter areas which were directly affected by the Chernobyl radiation. The grazing system is known by its Welsh name of "hafod a hendra" and involves the seasonal movements of animals from lowland winter pastures to "rough" grazing on largely unimproved hill areas in the summer (Owen 1981). Agrostis spp. is the major plant in the grazing areas. On improved pastures either rye-grass or Agrostis-rye-grass mixtures are also common. Fescue-Agrostis pastures constitute the main communities of unimproved hill grazing areas.
(Stapledon 1936). Most farms have varying combinations of improved pasture and rough grazing along with small amounts of arable land used to produce root crops or grain silage for supplemental winter feeding (Jones and Green 1984).

Between 1977 and 1984 the size of the Welsh sheep breeding flock increased from 3.1 to 4.4 million ewes. This large increase in animal numbers has meant that the grazing lands have had to be more intensively managed (Johns and Haines 1984) and a finely balanced system has developed to maximize the returns from the grazing resource. In general, animal management is dictated by the forage cycle. From early September to late October ewes finish up the remaining forage on the rough grazing areas and then are brought down onto improved pastures for breeding. The in-lamb ewes receive a root crop diet supplement to help maintain condition until just before lambing in late March. Lambing takes place over the next month with continuing diet supplements, likely silage-based. The ewes with lambs at foot are kept on rested improved pasture until the first flushes on the hills in early May. When possible these lowland pastures are rested for a year to eliminate intestinal worm parasite infestations in the young lambs (Rutter 1975). It is particularly important that lambs not be put on these pastures late in the year as this will lead to high levels of infestation. From early May until early September the ewes and lambs are moved to open mountain grazing. At this point a delicate matching of animals to available forage takes place. Grass productivity peaks in mid-June before the lambs are weaned and ready for slaughter. As the lambs grow their forage requirements increase. To prevent overgrazing, selective sell-offs of lambs take place in late summer and early fall. Over the last few years there have been considerably higher returns from carrying lambs to finish (Johns and Haines 1984) and the strategy of Welsh farmers has been to finish as many lambs as possible. Early lambs are finished light and sold to maximize the remaining forage for late finishers. In addition, those lambs which are likely to be extremely slow finishers are progressively sold (as stores) to be finished on lowland pastures in England and Wales. Again, this is in aid of freeing up additional forage so that larger numbers of lambs can be finished. Currently 60% of lambs are sold in finished condition compared to 20% in the late 1950's (Jones 1984). When all non-replacement lambs are sold off, the ewes are left on the high pastures until late October and the grazing cycle begins again. This lengthy description of the grazing system is necessary to underline the balance between available forage and animal numbers. Basically a system has developed which has two objectives: (1) to maximize the number of ewes which can be successfully over-wintered and (2) to maximize the number of lambs which can be finished on the farm. Hence, there is little margin for disruptions to the system such as resulted from the Chernobyl radiation.

Although a number of radionuclides were detected in the Welsh samples of Chernobyl fallout, those of major concern were iodine-131, cesium-134 and cesium-137. As soon as the escape of radioactive material was confirmed, the British government instigated a comprehensive monitoring program. Initially, attention was focused on fresh fruit and vegetables plus concentrations of iodine-131 in milk. Although levels rose in the period immediately following the passing of the nuclear cloud, recorded levels were well within those established in government safety guidelines. By the end of May the Ministry of Agriculture, Fisheries and Food (MAFF) was able to report that "levels of iodine-131 in milk and vegetables in England and Wales are now very low and are continuing to fall." Attention was concentrated on the longer-lasting cesium isotopes, particularly cesium-137 with its physical half-life (the period it takes to lose half the activity) of 30 years. Cesium-134 has a physical half-life of two years (O'Flaherty 1986). Although there are a large number of relatively confusing measures of radioactivity (Willie 1986), the one upon which policy decisions are based in Britain is the becquerel (Bq). A becquerel is one radioactive disintegration per second. The pre-Chernobyl background levels for cesium-137 on vegetation were generally less than 5 Bq per square metre. In the aftermath of the rain showers on May 2 and 3 readings as high as 1,785 Bq per square metre were recorded in North Wales. Radioactive fallout is initially deposited on soil, root mats and foliage. It may enter the plants either by absorption from the plant's surface or indirectly from the soil. Perennials and permanent pastures are contaminated more through the plant-base than the leaves as a mat of organic material exists on the soil surface which traps contamination.

The immediate problem in the wake of Chernobyl was, however, ingestion by livestock of surface cesium deposits on the herbage. Radioactive substances enter the body primarily through the gut but uptake also occurs in the lungs and through skin absorption. With steady intake, the concentration of the isotopes in tissue will initially increase and then reach a plateau. When ingestion ceases it is gradually eliminated. Once absorbed in the bloodstream cesium is rapidly distributed all over the body with resultant accumulations in the kidney and muscle. The biological (as opposed to the physical) half-life is a measure of the period after which an animal's body contains only half the amount of a particular ingested radioactive element, through excretion. Based on existing models the British government expected the half-life of cesium in lambs to be about 15 days and for cattle and sheep 40 days. It was these estimates upon which policy decisions were initially based.

As part of its general monitoring program for food, the government began sampling slaughter animals for radiation levels in early May. Given the large relative body size of cattle
and mature sheep, concentration levels were never considered sufficient to warrant any policy action. Throughout May, however, lamb samples showed increasing levels of cesium concentration. These high levels were the result of the smaller initial weight of lambs relative to forage intake and additional accumulations due to the young animal’s rapid growth rate. By mid-June sufficient lamb samples in North Wales, Cumbria and parts of Scotland were in excess of the Ministry “trigger” level of 1,000 Bq per kg and the government invoked the powers of the Food and Environmental Protection Act of 1985 to protect consumers. On June 20, 1986, the government issued an order which prohibited the movement and slaughter of sheep in designated areas of North Wales for 21 days. The disruption was expected to be short lived.

So began a wide range of policy initiatives which were to affect Welsh sheep farmers and their grazing economy for the next six months and which may have repercussions for their grasslands into the future. It is important to note, however, that the government believed that the disruption would be minimal, that most of the effect would take place before the need to market lambs to retain the balance between animals and forage, and that the policy was based on the projections of a relatively short half-life of cesium in lambs. In the light of the subsequent experience it would seem unlikely that such a policy would again be initiated.

Some 2.5 million sheep were affected by the movement ban in North Wales. Initially the situation unfolded as the government expected. Contamination levels fell sufficiently so that the restrictions were removed from 1,000 farms on July 3 and 750 additional farms on July 10, all within the government’s original 21-day period. However, even by July 3 it was clear that in some areas the levels of radiation would not fall below the “trigger” levels and the ban was extended for a further 21 days. As this would extend well into the period when farmers needed to sell some lambs to ensure sufficient forage, the Welsh Office Agriculture Department (WOAD) began advising farmers to alter their husbandry practices. Lambs which were near sale weights were to be separated and put on areas with only sufficient forage for maintenance to prevent them from becoming over-fat while late lambs were to be allowed to finish out as normal. A further 1,300 or so farmers were released in the next banning period but it became clear that a number of areas would not reach safe levels by the end of July and the ban was extended indefinitely on July 31. Monitorings continued and all through the late summer and fall areas were released from the ban as their contamination levels fell below the trigger level. By the end of the fat stock season in late October there were still 315 restricted farms.

It is not yet clear why the computer models used to project declining radiation levels were so inaccurate. One possible explanation is that the models were constructed using data from continually grazed pastures. Hence, once the first growth was consumed, subsequent growth was not contaminated and ingestion virtually ceased. The rough pastures of North Wales cannot be continuously grazed and hence sheep were progressively moving into new ungrazed areas of contaminated forage. Again, however, given the limited experience with nuclear contamination no data for such a grazing system was available.

By early August the disruption to the grazing system could no longer be ignored. Some farms unable to sell off fat lambs to reduce stocking densities, were carrying twice their normal number of sheep (Davies, 1986). Land held for winter grazing was being used to maintain lambs in condition. Further, stock was being forced onto rotation land where worm infestations were high, requiring costly additional handling to dose the sheep. Winter feed and silage were being consumed in some cases. Other farmers were hurriedly seeding late crops of rapeseed to supplement fall and winter feeding and the need to import feed was imminent. In other words there was a total disruption to the grazing system. On August 13 the government introduced measures to alleviate the pressure on grazing.

The policy introduced was known as a “mark and release” scheme. Sheep could be moved and sold from restricted areas if they were marked on the top of the head and neck with long lasting paint provided by the government. Such animals could be sold for further feeding but not slaughtered and once removed from the restricted areas, could not be returned. Areas were categorized according to the severity of contamination. Sheep from “low deposit areas” (LDA) were to be marked in green while those from high deposit areas (HDA) were to be marked with blue. As sheep are not individually identifiable by the use of ear tags or tattoos, no sheep from either LDAs or HDAs could be slaughtered until all areas with the same designation were de-restricted. In other words as the place of origin of individual sheep could not be identified, no sheep from, say an LDA could be slaughtered until all LDAs were declared safe. Clearly those purchasing such sheep were taking a considerable risk. First, it was not clear how long such lambs would have to be held, thereby putting their own grazing systems at risk. Second, as many of the lambs from the restricted areas were already in fat condition, holding them longer could only lead to overfinishing and price discounts. Of course individual purchasers assessed these risks and marked lambs were heavily discounted in the market. The government did offer sellers compensation for the discounts but these were poorly structured to encourage good grazing management. In any case, farmers, especially in LDAs, were now faced with a difficult choice—either mark and sell their lambs and wait for the, as yet, poorly defined compensation or hold on to the animals, not mark them and hope that their areas would be de-restricted quickly. In fact this choice was explicitly put to farmers by the government in its statement of August 13 whereby “farmers should consider very carefully whether they should apply for consent (to mark and release) now or to wait until the area in which their flocks are located is cleared from restriction”. Such a lack of clear direction no doubt encouraged some farmers to hold on to their stock and to continue overgrazing. It was not until September 29 that all of the LDAs were declared to be within the guidelines and green marked lambs could be slaughtered. At year’s end some HDAs were still restricted.

Initially there were concerns about feeding contaminated silage but quick and extensive testing allayed any fears by the end of September and farmers were able to reduce some of the pressure on the grazing land by early feeding of silage. By the end of September there were still an estimated 135,000 sheep which had not yet been removed from restricted areas. Testing of live sheep scanners—known as scintillation detectors—had been ongoing and by mid-October live monitoring of sheep was undertaken on a limited basis. Priority was given to areas with near safe levels and individ-
ual flocks were tested and safe sheep marked and released. By early December almost all animals which needed to be moved had been tested and sufficient monitors were available to undertake the final act, to scan those sheep sold off the HDAs which were outside the restricted areas and had been awaiting slaughter clearance since, in some cases, mid-August. Clearly the radiation policy had been overtaken by events and the persistent high levels of contamination in some areas required continued modifications to the scheme. Given the constraints to manpower and equipment and the sheer magnitude of the administration of the sheep movement regulations the apparent slowness of the government reaction is understandable and in and of itself probably not excessively damaging to the range resource. However, combined with the deficiencies of the compensation scheme, considerably more damage was done than was probably necessary.

It should be made clear that the British government was under no obligation to pay compensation to farmers as a result of the Chernobyl accident. Under the Wildlife and Countryside Act of 1981 and according to the Minister of Agriculture, it is the established principle that the "polluter pays." Given, however, that the polluter was the USSR, the need to compensate farmers was recognized from the earliest statements of the government. Under such circumstances compensation became a much more discretionary matter. The adequacy of the compensation is disputed but it is clear that the methods of compensation and their administration were selected primarily on considerations such as equity, simplicity and budget rather than the encouragement of activities to better manage a stressed resource. Compensation had three elements. The first provided a payment for the price loss resulting from lambs which become overfinished due to the restrictions. The second provided compensation for the discount received for marked sheep after the instigation of the "mark and release" scheme. The major problem with these two schemes was the lag between marketing and payment. The marketing delay caused considerable cash flow problems and the delay until payment made it more difficult for operators to bring in additional feed to alleviate the pressure on grazing resources. In the case of the second program this cash flow delay further encouraged farmers to hold on to their sheep in the hope that their area would be de-restricted and they would be able to receive the full market price immediately. This led to continued overgrazing. It would seem that some means could have been devised so that the subsidies were received within a day or two of sale. It is, however, the third aspect of compensation which was the least desirable in terms of resource management. This payment was to compensate for extra costs incurred—especially expenditures on feed. To encourage good resource management such compensation should have been implemented very early and it should have been tied directly to the importation of additional feed. This would have encouraged such imports and had the direct effect of reducing grazing pressure. In the end a headage payment was decided upon, no doubt for administrative convenience. Further, the government was exceedingly reluctant to undertake such a commitment and no announcement was made until September 24 with the actual levels not set until the details had been negotiated with the farmers' unions. Hence, farmers were left from late June until early October with no assurance that any feed costs incurred to reduce the stress on the grazing resource would be recoverable. It is not surprising that this, combined with uncertainty regarding prices and severe cash flow problems, caused many farmers to reduce expenses as far as possible and put most of the burden of the Chernobyl disaster on the grazing resource.

It remains to be seen what the long-term ramifications for the grazing economy will be. It will be the spring of 1987 before the effects on ewe condition and lambing rates of a winter on less forage will become apparent. Further, whether or not there will be carryover effects of the radiation into the summer of 1987 cannot be as yet assessed. However, some clear lessons are already suggested for any future nuclear contamination of rangelands wherever they occur.

First, if at all possible, market animals should be moved off of contaminated grazing as soon as possible. Movement to uncontaminated pasture will prevent the build up of radioactive material in such animals and relieve pressure on the grazing resource. At low levels of radiation breeding animals can be kept on the range to graze off contaminated grass. Second, if no uncontaminated areas are available then market animals should be sold at the appropriate time with full compensation and destroyed. This was actually suggested by some Welsh farm organizations but not accepted by the government. This would again reduce pressure on the range and might also help allay consumer fears that contaminated meat was finding its way to market. Third, any compensation scheme should be designed to explicitly include incentives to better manage the grazing resource. Fourth, the experience gained in Wales could lead to immediate calibration of live monitoring equipment and help alleviate many of the delays and disruptions caused by the post-slaughter sampling method. Large quantities of data will soon be available from Wales and other areas of the United Kingdom where contamination was heavy, as well as many areas of western Europe. Efforts should be made to acquire such information by organizations such as the Society for Range Management and others concerned with management of rangeland resources and studies encouraged to determine the applicability for local cattle and sheep operations. Only in this way will the extremely costly information arising from the Chernobyl accident not be wasted.

**Literature Cited**


