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DISCOVERING THE FUTURE: A NEW PECAN HUSBANDRY PARADIGM?

B. W. Wood[1]

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ABSTRACT

Pecan husbandry is presently driven by management strategies generally accommodating the natural growth habit of native trees--where trees are allowed to grow naturally with farmers striving to manage the consequences. While allowing for successful commercial cultivation, this contributes to many serious problems that presently plague the commercial industry. These problems collectively result in low yield efficiency at both the tree and orchard level and also limit the growth and prosperity of the industry. I present an alternate husbandry potentially allowing for substantially increased orchard yields (and efficiency) while greatly enhancing kernel quality, stabilizing production, and maximizing the use efficiency of orchard space. This paradigm is based on the control of tree size and the establishment of equilibrium between source and sink tissues. It allows for the farmer to rapidly fill allotted orchard space, to annually control tree size, and to largely control alternate bearing. This can be done on large trees by wise employment of selective limb pruning techniques and on small to medium size trees by appropriate annual wisping techniques. I suggest that unless unforeseen events suddenly increase demand for pecan, the future of the industry at the commercial level hinges on a new paradigm conferring greatly enhanced efficiency, and therefore "economic fitness".

The purpose of this report is to introduce a brief discussion exploring the future of the U. S. pecan industry and what researchers and growers might do to prepare for this future. This is done by pointing out an "economic fitness" problem and the suggestion of a possible solution.

The relatively poor "economic fitness" exhibited by the U.S. pecan industry is largely driven by the fact that pecan trees have been managed for generations by orchardists with the mind set of generally letting the tree grow its natural way and become as large as conditions allow. This strategy usually encompasses a brief effort in the early stages of tree growth to train a central leader or scaffold limbs. While this strategy lends itself to beautiful orchards and little or no efforts regarding training, it results in major biological and economic challenges which threaten the economic fitness of pecan husbandry. Trees allowed to grow according to their innate natures partition most of their resources into wood to ensure survival as they compete against neighboring trees. This strategy is essential in a riparian, or floodplain, habitat where pecan has evolved and adapted, but is a handicap when a stable supply of high quality kernels are the desired products of husbandry and orchard managers act to insure the tree's survival.

When viewed from the perspective of profitability, which is strongly linked to consistently high production of high quality nut meats, the traditional paradigm commonly practiced today possess three major disadvantages, plus a host of lesser problems. These three are: a) largely uncontrollable disequilibrium between source (foliage) and sink tissues (fruit); b) low intratree yield efficiency; and c) low intertree, or orchard, yield efficiency. This also causes problems with control of pests and nutrient element levels, wind damage, alternate bearing, marketing, etc. Therefore, within the context of profitability or economic fitness, trees allowed to grow naturally will generally insure a continuation of what we experience today. This traditional strategy is similar to the "Wag the Dog" effect (as compared to "Wag the Tail") where a relatively small aspect of husbandry is allowed to control or drive an endeavor.

As pecan scientists we have the opportunity to "Discover the Future" of pecan husbandry. To do so we must anticipate and innovate. The food and tree nut industries are in competition with pecan and are rapidly evolving. Unless there is a major unforeseen event that suddenly and greatly increases demand for food, the pecan industry will surely face considerable evolutionary pressures to improve "economic fitness". The same may also occur without such an event. Failure to enhance "fitness" will likely result in the U. S. pecan industry being slowly relegated to the "endanger species" list and possibly on the "extinct" list.
Market forces seem to be such that there are: a) increasing competition for the food dollar; b) greater competition by other nut crops; c) increasing importance of high quality kernels; d) and relatively slow development of domestic and foreign markets. To ensure that the commercial pecan industry continues to prosper it will be important that the industry be anticipatory and innovative. The industry's goal should be "to be at the right place at the right time". To do so it

[1]Research Horticulturist, USDA-ARS, Southeastern Fruit and Tree Nut Research Laboratory, 21 Dunbar Road, Byron, Georgia 31008.

must find solutions to the problems that are preventing it from possessing this competitive edge.

The existing husbandry paradigm results in peak yield efficiency for trees at age 9-15. Efficiency then declines due to increasing disequilibrium between sink and source tissues. The result is usually enhanced alternate bearing and lower "on year" kernel quality as the tree ages. Kernel quality during "on" years and the degree of annual fluctuations in yield are key measures of the magnitude of the disequilibrium problem. A similar efficiency peak also occurs in orchards insomuch that there is much wasted space in young orchards and much overcrowding in old orchards. There are few, if any, years during the life of orchards where trees are highly productive and orchard space is effectively used. Unfortunately (or fortunately in certain cases), these do not occur simultaneously. Additionally, varieties left to grow as they will, exhibit vastly different yield efficiencies. The challenge to "fitness" is to find a means of keeping individual trees at peak efficiency while also fully occupying orchard space throughout the life of the orchard. This combination obviously possesses great value.

The large trees produced from the traditional paradigm confer several biological problems that limit "fitness". For example, such trees present a canopy that approximates a conglomerate of smaller trees. This results in a great deal of wasted and poorly utilized space that could potentially be highly productive fruiting volume. This composite-like canopy filters out essentially all photosynthetically active radiation by the time the solar beam penetrates ~ 3-6 feet of canopy (depending upon variety), thus light starving most of the vast interior volume of the tree. Additionally, the resistance attributed to hydraulic conductance of water from the roots to the uppermost foliage becomes great enough in tall trees to substantially limit photosynthesis of the upper canopy. Tall trees are also prone to considerable reductions in photosynthesis (and leaf area) due to reduced levels of nutrient elements in the uppermost canopy due to reduced transpirational influx of xylem mobile nutrients. Tall trees also consume a relatively large amount of energy in dark respiration to support woody tissues constructed to allow for gainful competition with its neighbors for light and nutrients.

This traditional paradigm therefore presents an array of problems that appear to be beyond solution or are not economically feasible to solve. Attempts have been made for decades to offer solutions through improved management of nutrient elements, water, disease and insect pests, sunlight, weeds, adjustments in tree spacing, mechanical fruit thinning, etc., but have failed to truly solve the problem. These efforts have not focused on the real cause of low efficiency.

I propose that we are seeing the early phases of the emergence of a new paradigm where economic fitness will be greatly enhanced. While this new paradigm is yet to be born, its prototypes have been emerging for about three decades. The first clear evidence of demonstrated initiative to cast aside the traditional paradigm appears to have been made in New Mexico where the seeds of innovation found fertile soil under the nurturing care of Stahmann Farms, and perhaps other growers as well, who began experimentation with the concept of pruning and wisping to control tree size and alternate bearing to enhance economic fitness. Similar efforts to break with traditional mind sets soon occurred with innovative growers in Georgia, Texas, Arizona, and probably other locations. The vast majority of these efforts were mere "flash in the pan" events that were deemed to be unsatisfactory and therefore resulted abandoned. However, in modified form, such efforts collectively may trigger a revolution in the pecan industry. The ideal spawned in New Mexico was exported to Australia in the 1980's where it found fertile ground in the mind set and innovativeness of Deane Stahmann. His talent for intuitive judgement has probably done more to refine the idea of hedging and wisping than any other single individual. He has developed a system allowing for the consistent production of about 4,200 pounds of high quality in-shell nuts per acre. This is ~50% greater than that of the best orchards in the southwestern U. S. and ~150% greater than those of the southeastern U. S..

It is noteworthy that the two key technical innovations driving the development of a new pecan husbandry paradigm emerged from nontraditional pecan growing regions (New Mexico and Australia)--in environments relatively remote to mind set limitations imposed by tradition. The combined efforts and experience obtained by many innovative growers (such as Deane and Bill Stahmann, Keith Walden, and Paul Leonard,--to name a few) has now provided us with the knowledge base necessary to refine the concept of maximizing yield efficiency of trees and orchards. Such growers are paradigm pioneers who embraced a new ideal, a new set of rules, at a very early stage and did so in defiance of conventional knowledge. They did not wait until the numbers generated by research presented a convincing story. They exercised great faith in their own intuitive abilities and set about "changing the game rules" which may very well eventually evolve into "changing the game". This means that those unwilling or unable to adapt may eventually find themselves as an evolutionary "dead end".

Information generated by these "paradigm pioneers" integrated with my own perspectives of tree biology and pecan husbandry tempts me to suggest that the use of an appropriate hedging/wisping strategy is the future of much of the pecan growing regions, especially that of arid environments. Its future in humid environments is uncertain. This is primarily because of pecan scab disease. A fundamental question is whether the succulent growth generated by annual wisping will be compatible with pecan scab. Fortunately another technological advancement, the tangential fan sprayer with controlled droplet size technology , appears to offer great potential for improving coverage of canopy to allow for control of the disease. Recent advances in weather based spray strategies and timing of applications also enhance the feasibility of effecting a paradigm shift in the humid southeastern U. S.

There is not likely to be any one single hedging/wisping strategy will be best, especially since soil, variety, tree size, and tree spacing are major factors that potentially influence the final strategy. However, in general, the strategies that presently appears to be especially promising are as follows:

In planned, yet to be established, orchards: Choice of varieties will differ depending upon location, but in general 'Wichita', 'Apache', "Cape Fear', 'Shoshoni', 'Tejas', probably 'Navaho', and possibly 'Pawnee' appear to exhibit greatest potential. Trees should be established on the best soil available and planted in rows aligned N-S. The spacing should be ~ 15 ft. within the row and ~30 ft between rows. Trees should be left to grow normally during the first few years except for removal of limbs impeding upon future harvesting and herbicide applications. Trees should be grown to produce hedgerows by beginning hedging operations once tree limbs extend to about 8 ft from the trunk. Since pruning dwarfs trees, the less pruning probably the better, except for absolutely necessary training. Trees should be hedged back to about 4-5 feet on each side, resulting in a 8-10 "after hedging" canopy that will extend to 12-14 feet "after regrowth". This hedging is done on the eastern and western faces with trees allowed to grow in height until they are eventually topped and held at about 35 ft. This side hedging is done at a 5-degree angle to allow for a narrower top than base to facilitate light penetration. Repeated hedging, or wisping, is done each year thereafter to hold trees to their allotted space and to ensure equilibrium between sink and source tissues. This strategy will result in a minimal amount of wasted fruiting volume per tree and per orchard. Unknowns that need to be considered concerning this approach are: a) role of summer pruning of vegetative growth on the sides or tops of the trees to facilitate sunlight penetration to the interior of the hedge; b) the optimal ratio of hedgerow height to row width; c) the tree size to begin hedging; d) flat top or roof top topping; e) whether topping needs to be performed every year; and f) long-term influence of disease and insect pests on tree longevity as a result of wounding.

In existing orchards with small to moderate size trees. Existing orchards offer special challenges insomuch that intertree spacing and possibly orientation are no longer controllable (unless new trees are planted "in between" existing trees). Tree size also presents additional challenges. Anecdotal evidence suggest that in general, assuming trees are on a more or less square or diamond planting, trees should be pruned by whatever manner feasible to produce a skeletal structure extending about 1/3 (minus 2 feet) of the distance from the trunk of the tree to the adjoining row. Thus if row spacing is 40 feet then the tree should be shaped to ~11.3 feet from the trunk. Such trees therefore produce discrete canopies (vs. hedgerows). Repeated wisping should be on a 2-year cycle with opposite faces being done at each cutting with cuts being made at about 13 feet from the trunk. The top should be roof-topped when the side-cuts are made. Sides should be sloped at 5 degrees. An alternative is to hedge on a 4-year cycle with opposite sides being hedged at each 2-year cutting. This strategy is also suitable for large trees if they are first dehorned to conform to the limitations of the hedging machine.

In existing orchards with relatively large trees. A viable alternative to hedging and wisping appears to be that of selective heading back of certain scaffold limbs on an annual basis. The "paradigm pioneer" for this approach is Ray Worley of the University of Georgia and Joe Mitchell of Tombstone, Arizona. Large trees display a rather impressive array of primary and secondary limbs that are absent of foliage or fruiting points for 2/3 - 4/5 of their length. This causes great wastage of potential fruiting volume within the tree's canopy. The pioneering approach of Ray Worley was modified by the intuitive insight of Joe Mitchell insomuch that it was recognized that such trees need to be invigorated and to receive high levels of interior sunlight to existing supportive structures. This strategy was brought to my attention by Mike Kilby who readily recognized its potential. This strategy is to head back annually 1 or 2 major limbs by about 1/3 - 1/2 of their length. This is done being careful to avoid cutting in crotches since such cuts fail to induce the degree of vigor and fruiting response observed when cuts are made between crotches. The result is that such cuts, especially when initially localized in the upper interior of the tree, greatly improve the level of sunlight penetration into the interior of the canopy. This increased sunlight triggers the development of a multitude of dormant adventicious buds within the blind zone of the scaffold limb, resulting in a tremendous regrowth of shoots along the previously blind scaffold zone if the tree has been well watered and maintained. The shoots are highly fruitful the following year. This approach ensures that the tree is invigorated annually, is reduced in size, and approaches equilibrium between sink and source tissues. A "blind eye" (i.e., limbs selected almost at random) should allow the grower to substantially enhance the tree's yield efficiency, whereas a "keen eye" (carefully selected limbs) used in the selection process should produce truly remarkable results. The decision to "head" is made on a tree by tree basis and my not be an annual event, especially after 3-4 years of heading.

Both of the above described strategies can be used to ensure that intratree and intertree (orchard) yield efficiencies are greatly improved and become near optimum and that trees are maintained at or near equilibrium between sink and source tissues (although it will not necessarily totally eliminate alternate bearing it will be greatly minimized). This new paradigm also confers many additional advantages concerning leaf efficiency, nutrient disorders, pest control, wind damage, tree replacement, etc. This system allows the grower the option of rapidly filling allotted space with fruiting volume that produces high quality nut meats while also likely meeting the "economic fitness" demands of the future. Thus, the grower has evolved from the "Wag the Dog" approach of the traditional husbandry paradigm to the "Wag the Tail" approach of an emerging paradigm. This new paradigm operates under a new set of rules and is in effect an new game. Changing these rules has the potential for changing the world of pecan. As the new paradigm becomes increasingly accepted, it will be discovered that just about everything currently practiced in pecan culture will need to be reexamined for merit, thus giving pecan scientists plenty to do.

A new paradigm appears to be in the birth process; however its final form, or nature, is yet to be determined. Market realities and innovative growers guarantee its birth and continued evolution. As a new paradigm it puts everyone practicing the old traditional paradigm at risk. This includes growers and scientists alike. This presents a special challenge because the better we are at our existing paradigm, the more we have invested in it, and the more we have to lose by changing paradigms (or the rules, or the game). The conversion process will be slow with the most reluctant being the biggest losers in the end. As pecan scientists we have a special opportunity to assist in the maturation of this paradigm, therefore making what may become a revolutionary contribution to the enhancement of the economic fitness of the U. S. pecan industry.