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Review article

An analytical review of parameters and indices affecting decision making in agricultural mechanization

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Abstract

Agricultural Mechanization (AM) has been one of 20th century's most important innovations followed by producers to meet the world increasing demand for food, feed and fiber. The main purpose of AM is to achieve a stable approach for optimum productivity. Therefore, AM is considered as concepts and functions resulting in determination and definition of parameters and indices, which are required for implementation, application, and evaluation of AM. Decision Makers (DMs) require the parameters/indices as criteria to make the best decisions. Therefore, this paper seeks to define the concepts and functions as tools to estimate the criteria. Technical, economic, ergonomic, environmental, and cultural aspects of agriculture are the main criteria which influence the AM. A DM must be aware of the effect of each one and make the best decisions using the data. MCDM methods, such as AHP, LINMAP, and TOPSIS, are suggested to be used more in AM analyses. Fuzzy logic is the approach that helps DMs make better decisions.

Keywords: Capacities; criteria; efficiency; timeliness; utilization; workable time.

Abbreviations:
AHP: Analytical Hierarchy Process
AM: Agricultural Mechanization
DM: Decision Maker
FAHP: Fuzzy AHP
FTOPSIS: Fuzzy TOPSIS
LINMAP: Linear Programming for Multidimensional Analysis of Preferences
MCDM: Multi-criteria Decision Making
TOPSIS: Technique Ordered Preference by Similarity to the Ideal Solution

1. Introduction

AM could be described as application of the most locally appropriate tools, implements, machines, and approaches to make the most sustainable beneficial decisions. If AM is implemented in the right way, it will have a considerable effect on agricultural utilization. It will optimize inputs costs. Initial application of AM was tractor entrance to the land. But during last century or so, AM has found several interpretations; and the description was changed from tractorization to precision farming. This procedure gives evidence of AM maturity. In many parts of the world, AM has made a significant contribution to agricultural and rural development. Levels of production have increased, soil and water conservation measures were constructed, the profitability of farming improved, the quality of rural life enhanced, and development in the industrial and service sectors was stimulated (Bishop, 1997). Increasing land and labor efficiency by reducing the drudgery in farming operations bring in more land under cultivation, save energy and resources (seed, fertilizer, and water). Sustainable agricultural production, improving operators' comfort, safety, and convenience, protecting the environment by allowing precision operations and increasing the overall income are AM goals (Salokhe and Ramalingam, 1998). Mechanization is generally used as an overall description of the application of tools, implements and powered machinery (Clarke, 1997). Inns (1995) mentioned that AM development depends on the farmers' satisfaction and capability to identify opportunities for achieving sustainable benefits by improved and/or increased use of power and machinery, selecting the most worthwhile opportunity and carrying it through to successful implementation. Because of its obvious contribution, mechanical aspect of AM has been presented till now. But it was a progression of technological innovation that influenced all of society throughout the twentieth century (Foulke et al, 2000). Fernandes et al (2008) mentioned that even in high crowded populations, it can be difficult to attract or retain laborers to work in farm operations. Much of the stimulus for AM has come from laborer shortages in the more economically advanced countries. They described mechanization as tractorization. Mechanization reduces agricultural required labor and can reduce or remove the costs in countries which energy is cheap. But for poorer countries, mechanization forces increased costs caused by fuel, oil, engines and spares (Pretty, 2008). According to literatures,

AM must consider all aspects of agriculture. In some ideas AM refers to tractorization, while others add agriculture machinery usage to mechanization domain. Reduction of labor costs is the other aim that some others focused on. Choosing and using the most appropriate tractors and machines is not possible without considering technical and economical criteria. On the other hand, unemployment due to machinery substitution may create problems in social relations and cultural crisis will occur if AM is not implemented according to local conditions. Likewise, environmental effects of AM are important. There are some expressions which are currently used to assess and compare the AM status for regions:

2. Parameters and indices

AM status of a region is defined by parameters and indices. They include technical, economic, ergonomic, environmental, and cultural aspects of AM resulting in decision making. Some definitions and functions are applied to introduce the parameters and indices, they are listed as follow:

2.1. Technical aspect

Technical aspect of AM has been considered mainly as the AM status assessments. It refers to machinery parameters, characteristics, and capability. The parameters resulted in introduction of indices usable for machinery management.

2.1.1. Machine capacity

Agricultural machinery capacity is the rate at which an operation is accomplished. The rate is described as machine field capacity. Eq.1 and Eq.2 show machine capacity in terms of the area worked per unit of time and Eq.3 shows the index describing required machine capacity.

$$C_t = \frac{W \times S}{10} \quad (1)$$

$$C_a = C_t \times e \quad (2)$$

$$C_i = \frac{A}{T_a} \quad (3)$$

Where: C_t = theoretical machine capacity ($ha\ hr^{-1}$); W = machine theoretical width (m); S = field speed ($km\ hr^{-1}$); C_a = actual machine capacity ($ha\ hr^{-1}$); e = field efficiency (*decimal*); C_i = required machine capacity ($ha\ hr^{-1}$); A = field area (ha); T_e = available time (hr).

2.1.2 Field efficiency

Field efficiency is not constant for a particular machine, but varies with the size and shape of the field, pattern of field operation, crop yield, moisture, and crop conditions (ASAE, 2003) and is defined as the ratio of time a machine is effectively operating to the total time the machine is committed to the operation in terms of percentage or decimal. Factors indexed by Hunt (2001), decrease field efficiency and consequently machine capacity are as follow:

1. Turning time and time crossing grass waterways that machine mechanisms are operating (T_1).
2. Time to load or unload the machine's containers if not done on-the-go (T_2).
3. Machine adjustments time if not done on-the-go (T_3).
4. Maintenance time includes refueling, lubrication, and chain tightening, etc., if not done on-the-go (does not include daily servicing) (T_4).
5. Repair time when spent in the field to replace or renew parts that have become in operation (T_5).

Agricultural machines field efficiency can be calculated by Eq.4.

$$e = \frac{T_t}{T_e + \sum_{i=1}^{5} T_i} \quad (4)$$

Where: e = machine field efficiency (*decimal*).

Theoretical field time (T_t) is the time that machine is operating in the crop at an optimum forward speed and performing over its full width of action. The time is not practically achievable. Therefore, efficient time (T_e), the time which an operation is practically performable, was introduced (Eq.5).

$$T_e = \frac{T_t}{K_w} \quad (5)$$

K_w is the ratio of operating machine width to theoretical width in decimal (Eq.6).

$$K_w = \frac{W_e}{W} \quad (6)$$

Where: W_e = machine effective width (m).

The field efficiency evaluates the impact of machinery decisions and different operational strategies (Grisso et al, 2008).

2.1.3 Operation width

Farming machines have certain theoretical width, which remains constant, as the manufacturer validates. The requirements for best efficiency and quality are: the driving lines are exactly side by side, no gaps, no overlapping and the turning in headlands is made in minimum time. Parallel swathing assistants or light bars or autopilots help human driver to keep the machine in lane (Oksanen and Visala, 2007). The width is less than theoretical width and the division of operation width on theoretical width is K_w (Eq.6). There may be limitations which do not let an operator to work with theoretical width. The limitations may be caused by following reasons:

1. Farm size, shape, and length/width ratio
2. Soil texture, structure, moisture, and compaction
3. Crop yielding
4. Stubble intensity
5. Field levelness
6. Power source restrictions
7. Crop rows straightness

2.1.4 Operation speed

Each operation depending on its requirement needs a particular speed range. The speed ranges are variable based on: kind of operation, tractor size, operator skill, machine size, weather conditions, crop sensitivity to timeliness, and soil conditions. Therefore, it is not equal even for a given operation in different conditions.

2.1.5 Farm size and shape

Number of machines in relation to adequate areas is not a sufficient criterion to evaluate the situation of farm mechanization in different countries. Also, the farm size structure must be taken into consideration (Pawlak et al, 2002). On the other hand, if the field shape is not rectangular or if there are obstacles, the generation of a driving strategy is not so simple (Oksanen and Visala, 2007).

2.1.6 Material capacity

Capacity, when expressed only as area per time, is usually not a sufficient indicator of a machine's true performance, particularly with harvesting machines (Hunt, 2001). Material capacity (C_m) is the desired product material mass harvested per hour (Eq.7). For example, the material capacity of a combine is assumed the mass of grain (kilograms) harvested per hour, while a swather capacity is based on grass total mass harvested per unit of time.

$$C_m = C_a \times y \tag{7}$$

Where: y = crops yield ($kg\ ha^{-1}$)

This capacity depends on different parameters which are not equal under all the conditions, the parameters are as follow:

1. Combine weariness and mechanism.
2. Operator experience and skills.
3. Environmental conditions; weather temperature, humidity, suspended dusts, whiff speed, daylight period, and farmland geographical position.
4. Crop plants intensity and grain density.
5. Crops yielding.
6. Farmland area and shape.
7. Combine head width and container capacity and unloading system.
8. Land levelness
9. Crop height
10. Header height from the ground

Sorensen (2003) developed a planning model for harvesting capacity (Eq.8).

$$OC = \frac{60}{\left(\left(\left(\frac{h \times 600}{v \times e} + \frac{p \times b \times n}{e \times (1+a)} + k + (s \times h)\right) \times \frac{1}{h}\right) + \frac{m \times u \times 1000}{l} + (u \times c)\right) \times (1+q)} \tag{8}$$

Where: OC = the overall capacity ($ha\ h^{-1}$); h = the size of field (ha); v = the working velocity ($km\ h^{-1}$); e = the effective working width (m), p = the time for turning (*min per turning*); b = the field width (m); n = the number of turnings per pass (normally n=2); a = a model parameter dependent on field shape and travel pattern (a=1 in the case of driving back and forth in the swath); k = the turnings on treatment of headland (*min per field*); s = the stochastic crop and soil stops, adjustments, control, tending of machine, etc. ($min\ ha^{-1}$); m = the preparation for unloading ($min\ load^{-1}$); u = the expected yield ($t\ ha^{-1}$); l = the net tank size (kg); and c = the net unit of unloading time ($min\ t^{-1}$), q = an assessed rest allowance time amounting to 5% additional time.

2.1.7 Throughput capacity

The term throughput has come to mean the time rate of processing a total mass of materials through a machine. As an example, the throughput capacity of a combine is assumed to include the total mass of grain, chaff, straw, and weeds that enter the header. Throughput capacity ratings should be accompanied by a material moisture report (Hunt, 2001).

2.1.8 Power per unit of area

The demand for farm power and equipment caused by (Bishop, 1997):

- Replacement demand to maintain existing stock
- Increase in demand due to growth in number of farm businesses
- Adoption of mechanization inputs
- Substitution demand to replace traditional power sources

This index considered the quality of mechanization status (Almassi et al, 2005) and is equal to the ratio of total drawbar power in a region to total mechanized cultivated area (Eq.9).

$$PPA = \frac{P_d}{A_c} \quad (hp\ ha^{-1}) \tag{9}$$

Where: PPA = Power per unit of area ($hp\ ha^{-1}$); P_d = sum of total drawbar power (hp); A_c = cultivated area (ha).

Depending on crop, local conditions and needed operations, tractor depended or/and self-propelled machinery will be needed. But it should be considered that self propelled machines are not generally operated all over a region and the same for all kinds of crops.

2.1.9 Mechanization level

Mechanization level is an index surveying quantity in mechanization problems and is the ratio of mechanized operation to the total cultivated area (Almassi et al, 2005). The index is often estimated for individual crops especial operations separately (Eq.10).

$$ML = \frac{A_M}{A_c} \tag{10}$$

Where: ML = mechanization level (%); A_M = mechanized cultivated area (ha).

2.1.10 Mechanization capacity

This index indicates the combination of mechanization quality and quantity (Almassi, 2005). The index is the hours that a power is applied on per unit of area. In other words, mechanization capacity is the energy that is consumed per unit of field area ($hp.hr\ ha^{-1}$) (Eq.11).

$$MC = PPA \times T \tag{11}$$

Where: MC = mechanization capacity ($hp.hr\ ha^{-1}$); T = the time that power source is applied (hr).

2.1.11 Workable time

Lak and Boluki (2009) considered soil workability as an important parameter. First, they find critical period of mechanized agricultural operation timetable. Then, unworkable hours are subtracted from critical period. The method of estimation of unworkable hours is based on soil texture, rainfall, soil infiltration velocity, and soil workability moisture. The equations are derived from soil infiltration's functions. It is essentially a two-stage process under unsteady rainfall. Initially, the infiltration rate is equal to the rainfall application rate. After ponding, the infiltration rate begins to decrease until the rate approaches a constant value or final infiltration rate. The infiltration rate for each time increment is calculated by Eq.12 (Risse et al, 1994).

$$f = K_e \left(1 + \frac{N_S}{F} \right) \tag{12}$$

Where: f = infiltration rate ($m\ s^{-1}$); N_s = effective matric potential (m); F = cumulative infiltration (m); K_e = effective hydraulic conductivity ($m\ s^{-1}$). In this equation, F is obtained using the Newton-Raphson method (Eq.13).

$$K_e\ t = f - N_S \ln\left(1 + \frac{F}{N_S} \right) \tag{13}$$

Where: t = time (s).

The effective matric potential, N_s, is computed using Eq.14.

$$Ns = (\phi_e - \Theta_i) \times \psi \tag{14}$$

Where: ϕ_e = effective porosity ($m\ m^{-1}$); Θ_i = initial soil water content ($m\ m^{-1}$); Ψ = average capillarity potential across the wetting front (m) (Risse et al, 1994).

Alizadeh (2005) simplifies Green-Ampt equation to calculate infiltration in the same conditions (Eq.15).

$$f = \frac{A}{F} + B \tag{15}$$

Where: f = infiltration rate ($m^3\ s^{-1}$); F = cumulative infiltration (m); A,B = coefficients estimated by experiments.

On the other hand, statistical data are in terms of infiltration rate and rainfall height and can be calculated as Eq.16 and Eq.17.

$$f = \frac{A_c \times h_R}{T_{\inf}} \tag{16}$$

Where: h_R = *Rainfall height* (m); T_{inf} = infiltration time (s).
So:

$$T_{\inf} = \frac{A_c \times h_R}{f} \tag{17}$$

Finally, the time that soil is workable (T_W) is estimated by Eq.18.

$$T_W = T_c - T_{in\ f} \tag{18}$$

Where: T_c = critical period (s)

Critical period is the time interval in which most of the power sources are applied. In other words, most of the operations are done during the time. Critical period is extracted from farming operations timetable.

2.1.12 Utilization ratio

This index is the ratio of required capability to practical ability (Lak and Boluki, 2008) (Eq.19):

$$R_u = \frac{RC}{PC} \tag{19}$$

Where: R_u = utilization ratio (decimal); RC = required capability (ha); PC = practical capability (ha). The ratio indicates the relation between farmland area which must receive mechanized services (RC) and the area which the existing power resources can support (PC). Ratios less than 1 are preferred, because under the conditions, the operation timeliness risk will be declined. On the other hand, ratios less than r (r is a measure between 0 and 1 that shows the optimum ratio) decrease the utilization. The measure of r depends on the regional (atmospheric stability, energy availability, tractor and machinery reliability, timeliness and operation workability) conditions.

2.1.13 Required capacity

The term required capability is the area that should be mechanized and serviced by available tractors considering timeliness. It is not essentially equal to A_c, because complete mechanization of A_c may not be required. It is because of economical, cultural, environmental or even technical aspects of AM.

2.1.14 Practical capability

Practical capability is the area (ha) that can be supported by existent tractors. Practical ability depends on number of tractors, timeliness and required time for preparing each hectare of farmlands (Eq.20) (Lak and Boluki, 2008).

$$PC = \frac{N \times T_W}{t_m} \tag{20}$$

Where: N = number of available tractors; t_m = required time for preparing each unit of mechanized cultivated area ($s\ ha^{-1}$).

2.2 Economic aspect of AM

Machinery is costly to be purchased, owned, and operated. These costs can be divided into fixed, variable, and timeliness costs.

2.2.1 Fixed costs

Ownership or fixed costs begin with the purchase of the machine, continue for as long as it is owned, and can not be avoided by the manager except by selling the machine. These costs involve depreciation, interest, taxes, insurance, housing, and leasing (Kay et al, 2008).
Ownership costs are seemingly independent of use and are often called fixed costs or overhead costs (ASAE, 2003). Depreciation is the cost to which more attention is paid.

2.2.1.1 Depreciation

Depreciation reflects the reduction in the value of an asset with use and time (ASAE, 2003). Eq.21 shows a simple approach (straight-line method) to calculate the depreciation:

$$D = \frac{(p-q)}{N} \times 100 \qquad (21)$$

Where: D = annual depreciation (%); p = initial machine price ($); q = salvage value ($); N = years of machine life Depreciation varies each year and is dependent upon the depreciation method used (Ibendahl and Norvell, 2007). Eq.22 represents declining-balance methods in which the depreciation is not the same during the machine's life (Hunt, 2001) (Eq.22).

$$D_{n+1} = P\left(\left(1-\frac{x}{N}\right)^{n} - \left(1-\frac{x}{N}\right)^{n+1}\right) \qquad (22)$$

Where: D_{n+1} = amount of depreciation charged for year $n+1$; n = number representing age of the machine in years at the beginning of the year; x = ratio of depreciation rate used to that of straight-line method (x may have any value between 1 and 1.5).

2.2.2 Variable costs

Operating or variable costs are directly related to use. These costs are caused by machine application. Repairs, fuel and lubrication, labor, and rental costs are of operating costs (Kay et al, 2008). ASAE (2003) suggested a method to measure the accumulated repair and maintenance cost (Eq.23).

$$C_{rm} = (RF1) \times P \times \left[\frac{h}{1000}\right]^{(RF2)} \qquad (23)$$

Where: C_{rm} = accumulated repair and maintenance cost ($); $RF1$ and $RF2$ = repair and maintenance factors; P = machine list price in current dollars; h = accumulated use of machine (hr).

2.2.3 Timeliness costs

Timeliness is the term that defines the most appropriate time or period of time that agricultural operations can be done with the highest efficiency. Ignoring operation timeliness creates economical problems for producers. Timeliness costs due to machine capacity and efficiency can be considered as another kind of cost. Non-appropriate machinery selection may affect the cost. Too small machines need more time to operate and postponing operations results in excessive costs, however, high capacity machines ownership costs are not economically rationalized as well as wide operating width makes problems like declination in machine efficiency that result in more costly operation. Schuler and Frank (2005) defined timeliness as a certain time at which every field operation is best done. In their idea, if the operation is not done at that time, the quantity and/or quality of the crop will be reduced. Salokhe and Ramalian (1998) believed that timeliness affects the crop yield significantly and the extent of farm power available during critical period of operations like sowing and harvesting, determines the level of timeliness that can be achieved. Timeliness costs vary widely. Variation is expected among regions, crop varieties, time of the season, and machine operations. Timeliness costs are essentially zero for those tillage and other operations where there is little need to finish quickly (ASAE, 2003). The timeliness cost is estimated from a timeliness coefficient obtained from ASAE D497. The annual timeliness cost for an operation can be estimated by Eq. 24 (ASAE, 1999).

$$W = \frac{K_3 A^2 YV}{ZGC_i(pwd)} \qquad (24)$$

Where:
W = annual timeliness cost ($); K_3 = timeliness coefficient obtained from crop research reports (ASAE D497.4); A = area (ha); Y = yield per area ($kg\ ha^{-1}$); V = value per yield ($\$\ kg^{-1}$); Z = 4 if the operation can be balanced evenly about the optimum time, and a value of 2 if the operation either commences or terminates at the optimum time; G = expected time available field work each day (h); pwd = probability of a working day ($decimal$); C_i = machine capacity ($ha\ h^{-1}$) K_3 can be estimated by experimental data obtained in real conditions and is not supposed to be the same under any condition.

2.3 Ergonomics and safety

Using ergonomic ideas (human engineering or coordination sciences among human, environment and machine), will cause health, succulence, welfare and safety of personnel and consequently causes an increase in work productivity (Behfar, 2009). Development of safer equipment and minimization of accidents are important links in enhancing farm mechanization strategies. A small light vehicle is inherently safer than a large one (Blackmore et al, 2005). The farmers must be given training on the safe operation of the machinery, how to overcome troubles and prevent accidents. Safety must be given prime importance as most of the large machineries are very powerful and dangerous if they are not handled properly (Salokhe and Ramalingam, 1998).

2.4 Environmental aspects of AM

Mechanization is not an "all or nothing" process. Levels and types of improved mechanical technologies need to be appropriate, that is, compatible with local, agronomic, socio-economic, environmental and industrial conditions (FAO, 2008). Mechanization can have both positive and negative impacts on the environment although it is the negative ones that tend to be most frequently highlighted. The positive

effects include timelier field operations, which will allow farmers to avoid having to work in fields when conditions are poor, more efficient use of water particularly in rice production, and better weed control (Clarke, 1997). Inappropriate selection and use of certain mechanized inputs, mechanization has often become a burden to national budgets and the farming community, leading to financial losses and restricted agricultural production, as well as environmental degradation (Bishop, 1997).

2.5 Cultural aspects of AM

Pawlak et al (2002) mentioned that the laborer(s) required per hectare depends on level of mechanization, production systems, working conditions (size of fields etc.) and, of course, on crop and its yield. It is important to realize that the elastic final demand provided by export markets played a crucial role. Without these export possibilities, areas planted, employment and agricultural output would have expanded less and mechanization would probably have proceeded at a slower pace. If final demand was very inelastic, mechanization could possibly lead to a reduction in agricultural employment even if extra land were available (Pereira, 1982). Agricultural employment fell substantially both in absolute and relative terms. Laborers were reemployed in the nonagricultural sectors of the economy rather than in agriculture itself (Pereira, 1982). AM affects rural society culture, economy, employment, and utilization systems. Under some conditions machines operate more efficiently than laborers; however, it is not a demonstrated rule under any condition. The high capacity makes producers fire insufficient laborers and since the production system profit is increased, unemployment is increased and cultural problems will be occurred unless unemployed laborers are absorbed in other divisions such as machinery service, operation, or maintenance. They may be also absorbed in other industries.

2.6 Decision making

Without decisions, nothing will happen. Even allowing things to drift along as they are implied decisions, perhaps not a good decision, but decision nevertheless. The decision making process can be broken down into several logical and orderly steps (Kay et al, 2008):

1. Identify and define the problem or opportunity.
2. Identify alternative solutions.
3. Collect data and information.
4. Analyze the alternatives and make a decision.
5. Implement the decision.
6. Monitor and evaluate the results.
7. Accept the responsibility.

Agricultural environment is dynamically variable under uncertainty. Energy, laborer, and input costs, markets conditions, crop yielding and prices, machinery service availability, pest and disease infection, environmental conditions, and even economical and political strategies affect agricultural productivity. A successful DM must be aware of the conditions and know the importance of each. It is known that all of the criteria affecting agriculture are not of the same influence and equal under different conditions. Therefore, it is suggested to the DMs to consider AM as the main part of agricultural system and to be familiar with MCDM methods. Methods such as AHP, LINMAP and TOPSIS are of MCDM methods. AHP is a method which ranks alternatives from the best to the worst. TOPSIS estimates the alternatives adoptability according to their distance with the positive ideal and the negative ideal points. Meanwhile, LINMAP method follows the nearest alternative to the ideal point. Fuzzy logic approach is another intelligent computing tool that is competent to be applied to wide variety of problems. Primary aim of Lotfi Zadeh which introduced the notion of a "fuzzy set" in 1965 was to set up a formal framework for the representation and management of vague and uncertain knowledge. Fuzzy set theory plays an important role in dealing with uncertainty in plant modeling applications (Sadoghi and Hosseini, 2007). FAHP and FTOPSIS can be developed to decline the problems with AHP and TOPSIS.

Results and discussion

AM definitions and indices are correlated together and mechanized systems analysis requires specialists to consider agricultural production procedure elements one by one. AM is an approach to find the best fitting procedure to achieve the most stable benefits. Sustainability of production is the aspect that a DM must consider. So, ergonomic, environmental, and cultural conditions are the criteria which a DM must consider in addition to technical and economical aspects of AM. Sustainable development of agriculture can be achieved by using simple manual tools in a region or may be implemented by high technologies such as precision farming and robots in other regions. Thereby, AM is not just to use the same farm machinery, generally. AM basic principles, concepts, and formulas have been discussed. These formulas are general and successful mechanized agriculture system analysis needs to consider all the aspects of technologies entrance to agricultural fields. It is suggested that the agricultural producers and DMs not to focus on agricultural machinery management as the unique purpose of AM, but technical, economic, ergonomic, cultural, and environmental aspects must be taken into account to make the most appropriate decisions. On the other hand, decisions must be based on MCDM methods principles. Therefore, it is recommended that DMs, especially AM specialists, be familiar with MCDM methods and make the best decisions to help the agriculture be sustainable.

Conclusion

Indices obtained by AM parameters were introduced and defined. The functions were developed and methods were described. Agriculture was considered as a complicated system which is influenced by technical, economical, ergonomic, environmental, ergonomic, and cultural criteria. It was recommended to use MCDM methods to make the best decisions according to the criteria. AHP, TOPSIS, LINMAP were introduced as the methods. Fuzzy logic may ameliorate the decision according to real conditions.

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